FSM Maritime Ecosystem Digital Twin

FSM-MEDT | Scientific and functional dossier | v3.0 RC1 RO/EN | English editorial v2.0

Document status: Under development and internal verification. This is a local demonstrative model and must not be represented as a fully validated or live-synchronised operational digital twin.

1. Identity and purpose

FSM-MEDT is the fourth and last instrument in the current FSM research series. It explores how a maritime ecosystem may change over time when disturbances propagate through explicitly declared relationships among components and functions. It adds dynamic dependency modelling; it does not replace the MN evidence base, Atlas tactical exercise engine or SMEA strategic interpretation.

2. The research questions it addresses

- How can one disturbance transmit effects across components and functions?
- How do functional continuity and individual component availability differ?
- How do time lags, persistence, recovery rules and changing dependencies affect system behaviour?
- Can substitution and reallocation maintain an essential function under limited resources?
- Which uncertainties and sensitivity assumptions materially affect the resulting trajectory?

3. Demonstrative scope and data model

The supplied RC1 contains a fictitious Black Sea multisectoral demonstration with 25 components, six subsystems and seven functions. Components may have identity, category, baseline, provenance and uncertainty. Relations may carry direction, type, validity, weight and delay. The demonstration is illustrative, not a measurement of the real-time condition of the Black Sea.

A researcher can define alternative ecosystems, components, functions and connections and observe a schematic graph or map. Institutional relationships can be descriptive without imposing numerical causality.

4. Static, temporal and cascading simulation

The model includes alternative static propagation conventions and a time-stepped simulator for scheduled events, recovery, substitutions and changing functional availability. Researchers may compare baselines with disturbances, trace delayed consequences, assess sensitivity and examine how different rules affect modelled outcomes.

Its calculations express what follows within the declared model. They do not establish a verified forecast of real port operations or maritime resilience.

5. Research dossier and governance

The RC1 package includes versioned research records, assumptions, source declarations, research annotations, exports and reports intended to preserve interpretability. It separates what the model assumes from what empirical evidence independently verifies. The RO/EN interfaces allow use in bilingual research settings.

6. Value to potential users

Potential users include complex-systems researchers, maritime security analysts, resilience researchers and educators seeking to compare causal assumptions and dynamic policies in a controlled, reproducible environment. It is not appropriate in RC1 for live monitoring, authoritative operational planning, certified real-world state estimation or authenticated multiuser deployment.

7. Relations to the other three instruments

Other programme	Complementarity / status
MN – Strategic Dynamics	May supply documented contextual reference for model assumptions; no live data synchronization shown.
FSM Maritime Atlas	Focuses on tactical event sequences; MEDT focuses on propagation through ecosystem dependencies over time.
FSM-SMEA	Provides strategic reasoning and collaborative evaluation; MEDT could supply dynamic modelling results in future, but no automatic RC1 integration is demonstrated.

8. Internal checks and the path to a real digital twin

Local numerical test suites supplied with RC1 were reported as passing during the archive review. That result checks selected computations, not physical-system fidelity or operational readiness. Persistence after an actual browser restart, invalid import handling and other deferred checks require real-environment verification.

A defensible operational digital twin would require identified physical referents, appropriate data ingestion, update cadence, calibration, comparison with observed system behaviour and sustained validation. Until then the appropriate description is experimental dynamic ecosystem modelling / digital-twin research candidate.

9. Conclusion and editorial status

FSM-MEDT provides the experimental dynamic dimension missing from a purely documentary, tactical or interpretive approach. It completes the conceptual series without claiming that the four applications already form one synchronised technical platform. This dossier remains provisional and is to be updated as internal checks and empirical validation mature.

Sources: FSM-MEDT v3.0 RC1 RO/EN, README and JSON contract, deferred-check records and test reports; FSM research vision; cross-reviewed editorial v2.0.