

1. Motivation

The Problem

- Seaports are critical nodes in global supply chains — yet tsunami risk frameworks rarely quantify port downtime or the indirect supply-chain losses that propagate beyond the directly affected ports.
- A major event disrupts not only hit ports but cascades through the maritime trade network, amplifying trade losses well beyond the source ports.

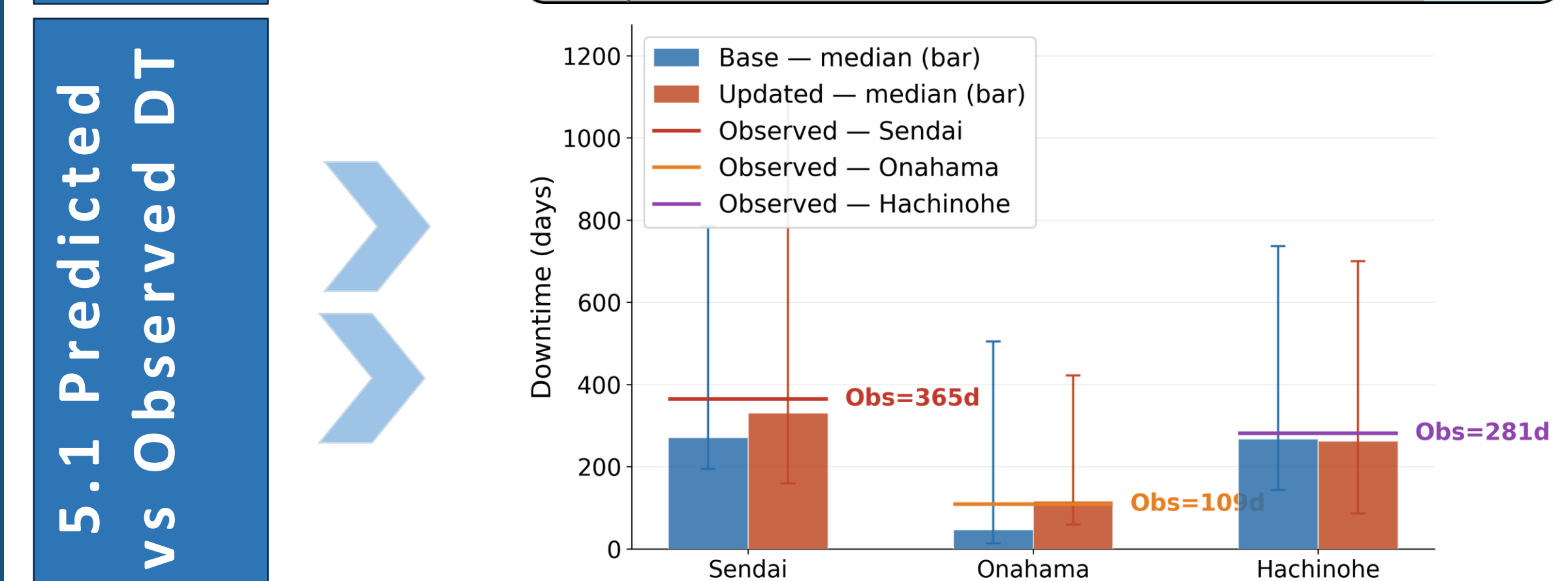
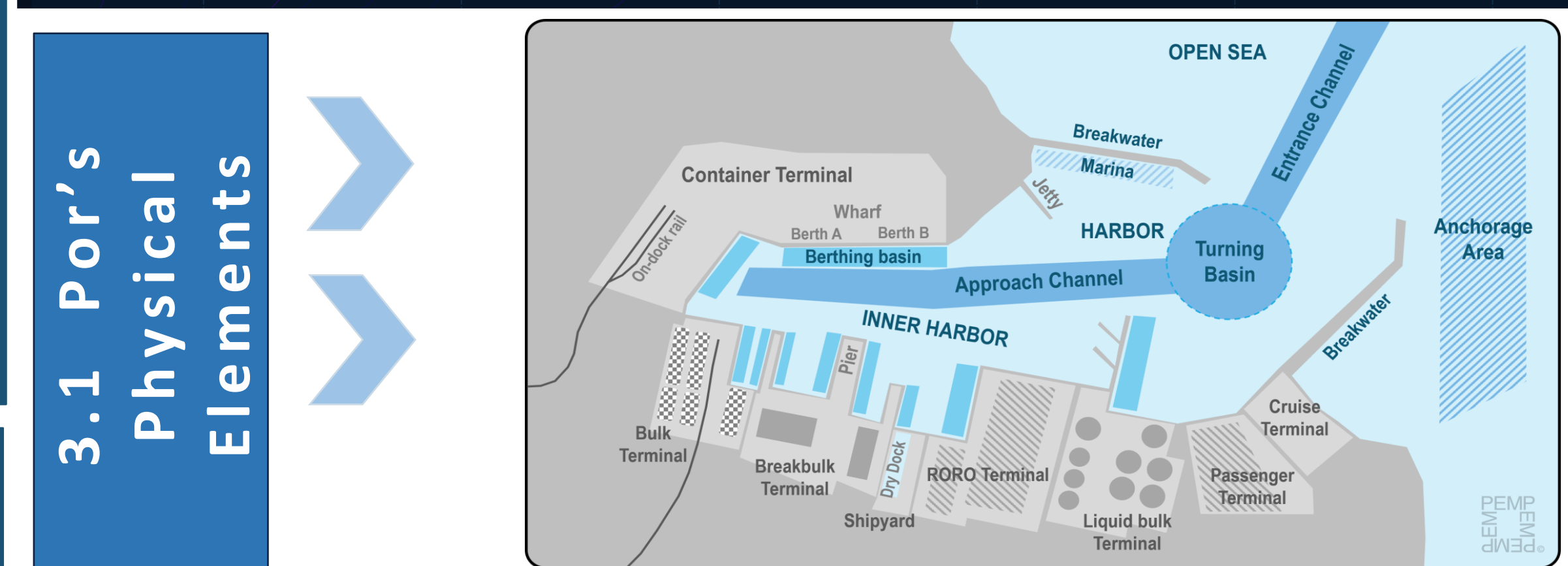
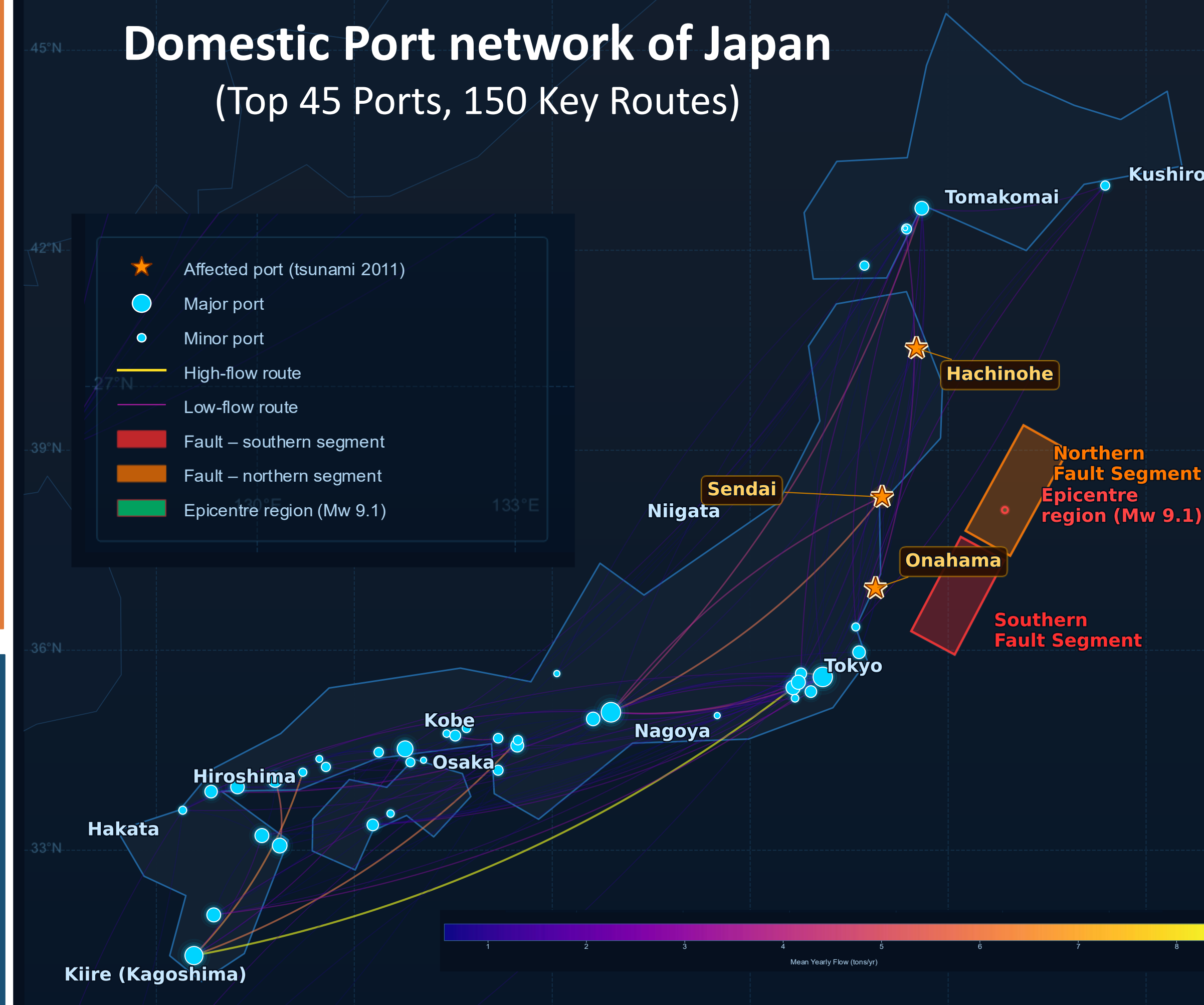
Key Gaps

- No probabilistic framework links per-port physical damage → downtime → network-wide indirect throughput loss
- Stochastic outbound/inbound propagation rarely applied to multi-port disruptions

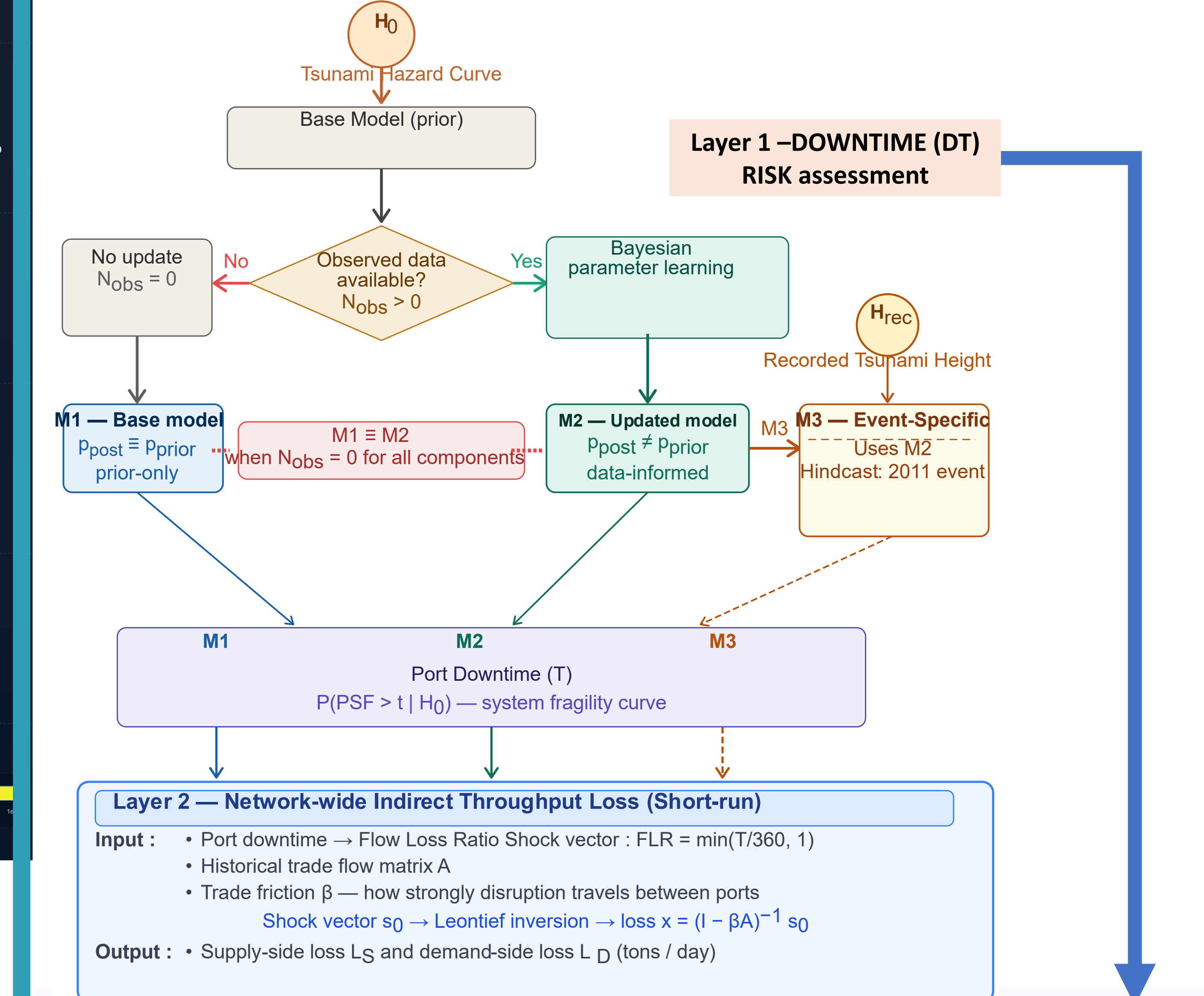
2. Event & Data

- 2011 Great East Japan Earthquake and Tsunami
- Data sources:
 - Tsunami Hazard curves/Global Tsunami Model
 - DEM: Elevations for flow-depth conversion
 - HAZUS Tsunami Model + Literature review
 - Observed data: Damage, Restoration Time (RT), per-component RT records
 - Port flow network: ≈ 950-ports; Japanese domestic maritime trade records

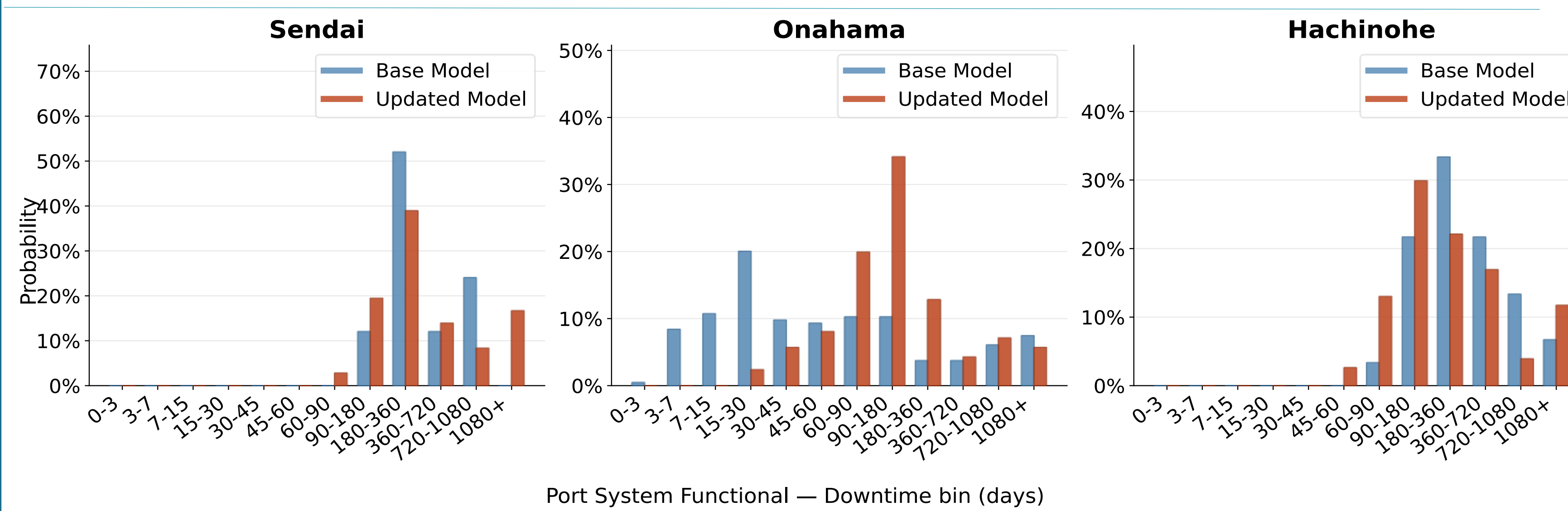
3. Concept



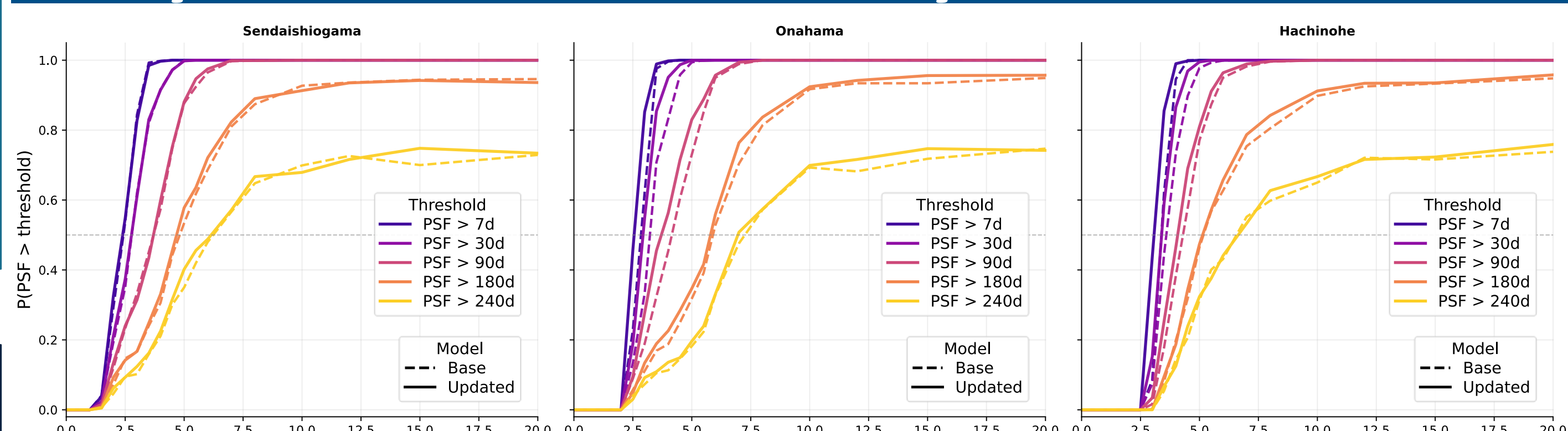
4. Framework 2-LAYER ARCHITECTURE



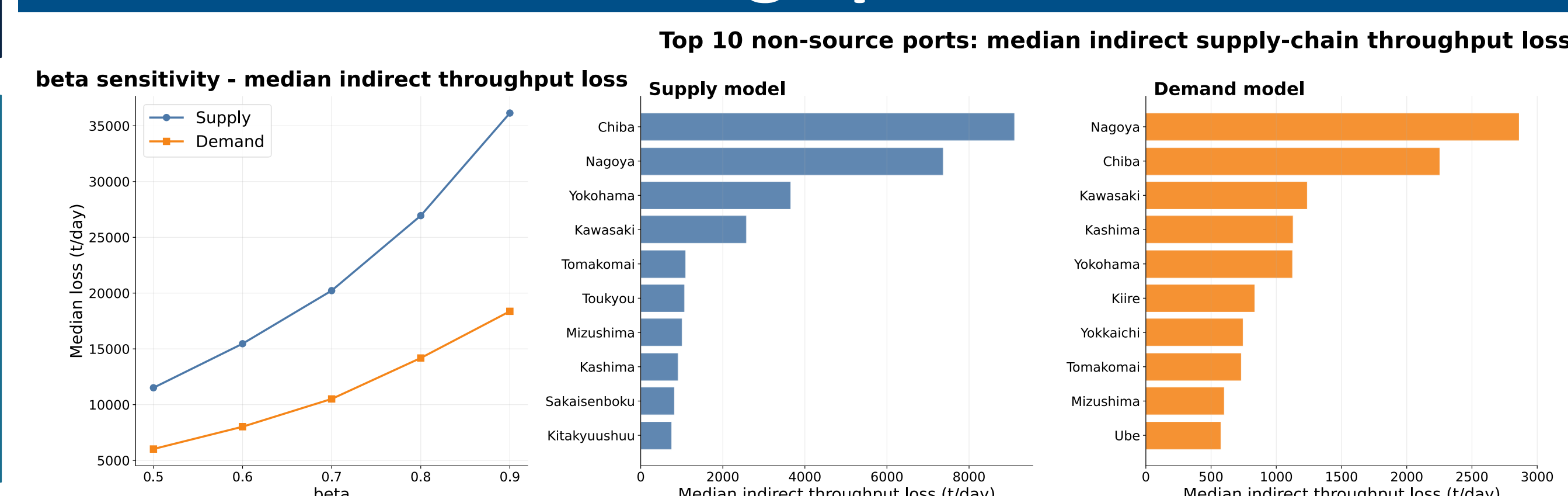
5. Port Downtime (2011 Tohoku Tsunami)



6. System Functionality

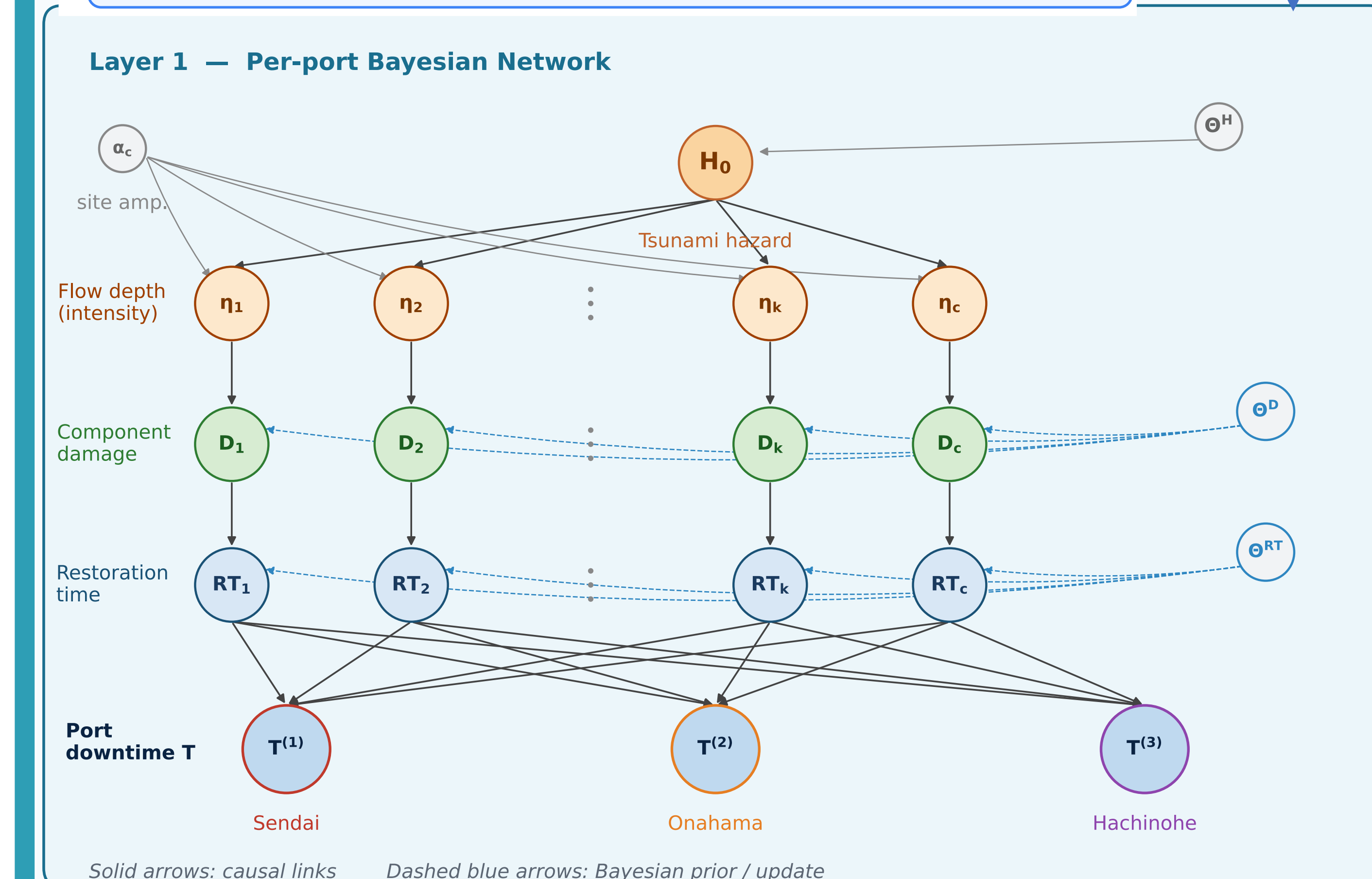


7. Indirect Throughput Loss



8. DISCUSSION

- Updating fragility and restoration with observed post-tsunami evidence materially shifts downtime distributions.
- Binary throughput assumption (zero during downtime, full thereafter) ignores the partial-operation phase, potentially overestimating indirect losses. Actual indirect losses will be lower as ports reroute and shippers substitute beyond what β captures.
- β (shock transmission factor): Uniform proxy for unmodelled adaptation — lower β implies greater substitution and rerouting capacity across all port pairs.
- Framework generalizes to any single-port or multi-port system, enabling probabilistic risk assessment at both asset and network scale.



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CONTACT & LINK TO ABSTRACT

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