# Module XX – Test Strategy & Capsule Coverage Design

Version: 4.1 | Classification: CTO Mandatory (Simulation & Robustness Assurance)

Scope: Test case structure, capsule replay logic, simulation paths, audit-driven injection

## 0. Purpose & Audit-Aware Test Imperative

This module defines a unified, capsule-based test strategy for MaxOneOpen v4.1. It provides capsule injection validation logic, replay chain simulation, fork response evaluation, and policy-collision reaction testing. It ensures runtime trustworthiness through reproducible test scenarios bound to certification conditions.

## 1. Test Dimensions & Validation Targets

Test goals:  
- Capsule injection and replay integrity (Ledger + Audit alignment)  
- Fork detection and FAC resolution logic  
- Federation anchor trace and consensus reentry  
- Grace Capsule issuance and GRCC revalidation  
- Alert emission and observer signal propagation  
- Certification downgrade and recovery simulation

## 2. Capsule Test Structure

Each test set is composed of:  
`Test Set = { set\_id, capsule\_series[], trigger\_point, replay\_variant?, downgrade\_expected?, fork\_condition? }`  
- Example Trigger: duplicated Execution Capsule → emits RAC + CRC  
- Expected Result: alert confirmation, blocked reentry, downgraded CCC score

## 3. Simulation Capsule Requirements

Simulation-validated capsules (for Module 17):  
- Must be reproducible (same hash on re-run)  
- Must invoke chain overlays (Forks, Alerts, GRCC)  
- Must represent Tier-restricted behavior violations  
- Must produce deterministic audit overlay trail

## 4. Capsule Coverage Index (Minimum Required)

- Execution Capsule (EC) with and without conflict  
- Replay Capsule (RAC) triggered via duplicate stream  
- Fork Anchor Capsule (FAC) validation path  
- Grace Capsule + Recovery Flow (GC → GRCC → REC)  
- Alert Capsule Chain (FDAC, PCC, TVC)  
- Federation Reconciliation (FRC + FCC)  
- Certification downgrade and Reentry simulation (CCC + RFC)

## 5. Output Format & Certification Binding

- Each test simulation outputs a `Simulation Confirmation Capsule (SCC)`  
- SCCs are required for full scoring in Module 17 (CTO Certification)  
- SCC must be hash-bound to all test capsules, triggers, and ledger states  
- Unverifiable or partially broken test sets reduce simulation score coverage