# Module 14 – Audit Engine & Observer Signal Processing

Version: 4.1 (Final CTO Edition)

Layer: Audit Capsule Review, Observer Alert Feed, Replay Detection, Role Differentiation

Status: RELEASE

Dependencies: Modules 06, 13, 17, Capsule Alerts, Grace Recovery

## 0. Purpose & Real-Time Audit Enforcement

This module defines the logic for capsule violation detection, observer-class signal delivery, and capsule trace enforcement across runtime and sovereign zones. It enables certification-grade audit trail replay, alert-based reaction protocols, violation summaries, and policy conflict exposure. Audit roles are clearly segmented to maintain trust zone isolation and runtime visibility boundaries.

## 1. Audit Capsule Types & Enforcement Roles

Audit Engine processes the following capsule types:  
- Trust Violation Capsule (TVC)  
- Replay Attempt Capsule (RAC)  
- Fork Alert Capsule (FDAC)  
- Grace Capsule (GC) and Grace Confirmation (GRCC)  
- Observer Snapshot Capsule (OSC)  
- Audit Summary Capsule (ASC)  
Enforcement roles:  
- Sovereign Audit Node: full trace view  
- Operator Auditor: partial capsule scope  
- Public Observer: summary access only

## 2. Capsule Replay Detection & Policy Collision Trace

Replay protection logic:  
- cross-zone hash scan  
- chain sequence delta detection  
- time-window drift validation  
Conflicting rule traces emit:  
- `Policy Collision Capsule (PCC)`  
- `Fork Violation Capsule (FVC)`  
- Audit chain divergence overlay

## 3. Alert Signal Interpretation & Visualization Overlay

Alerts are streamed and visualized in:  
- Capsule Drift Map (CDM)  
- Fork Trace Viewer (FTV)  
- Trust Escalation Monitor (TEM)  
- Sandbox Violation Feed (SVF)  
Observer-level filters are applied per zone, tier, and origin capsule ID.

## 4. Violation Summarization & Certification Impact

Each violation capsule is scored and compiled into:  
- `Violation Summary Capsule (VSC)`  
- linked to role responsibility and capsule ancestry  
- referenced in certification downgrade triggers (Module 17)  
Unresolved VSCs with class HIGH prevent full certification or reentry.

## 5. Grace Recovery Trace & Observer Revalidation

When Grace Capsules are active:  
- runtime audit is paused in primary scope  
- fallback audit overlays validate capsule continuation  
- successful reentry issues `Grace Replay Confirmation Capsule (GRCC)`  
- all audits post-GC must include origin hash rebinding