



e-ISSN: 2319-8753 | p-ISSN: 2347-6710

IJIRSET

International Journal of Innovative Research in
SCIENCE | ENGINEERING | TECHNOLOGY



INTERNATIONAL JOURNAL OF INNOVATIVE RESEARCH

IN SCIENCE | ENGINEERING | TECHNOLOGY

Volume 12, Issue 2, February 2023

ISSN INTERNATIONAL
STANDARD
SERIAL
NUMBER
INDIA

Impact Factor: 8.118



9940 572 462



6381 907 438



ijirset@gmail.com



www.ijirset.com

Landing Zone Architecture Patterns for Regulated Enterprise Workloads on Oracle Cloud Infrastructure

Baleeswara Bolleddula

Senior Oracle Applications Database Administrator, USA

ABSTRACT: Regulated enterprise workloads migrating to Oracle Cloud Infrastructure (OCI) require a pre-defined, policy-enforced architectural baseline - a Landing Zone - that establishes tenancy structure, network segmentation, identity governance, security controls, and compliance alignment before any workload deployment begins. Ad hoc OCI deployments in regulated industries consistently produce audit findings, security misconfigurations, and costly post-deployment remediation that a Landing Zone architecture prevents.

This paper presents a structured framework for designing and deploying OCI Landing Zones for regulated enterprise workloads, covering compartment architecture, hub-and-spoke VCN topology, IAM policy design, Security Zones, OCI Cloud Guard, Vault key management, unified logging, and compliance alignment with CIS OCI Foundations Benchmark v1.2, NIST CSF, PCI DSS v3.2.1, HIPAA Security Rule, and ISO/IEC 27001:2013. A deployment automation framework and operational governance model complete the practitioner reference. All cited sources pre-date February 2023.

I. INTRODUCTION AND FRAMEWORK OVERVIEW

A Landing Zone is the foundational, pre-configured cloud environment into which enterprise workloads are deployed. It establishes the structural guardrails - account/tenancy structure, network topology, identity governance, and security policy - that govern every subsequent workload deployment. In OCI, the Landing Zone concept maps to a set of Terraform-deployable infrastructure primitives: compartments, VCNs, IAM policies, Security Zones, Vault instances, and Cloud Guard targets, configured as a coherent, policy-enforced baseline.

For regulated enterprises - financial services, healthcare, government, critical infrastructure - the Landing Zone is not optional. PCI DSS Requirement 1, HIPAA Security Rule §164.312, CIS OCI Benchmark Controls 1–5, and NIST CSF Protect function controls all require the structural isolation, access governance, and audit trail that a properly designed Landing Zone provides from the first workload deployment forward.

■ OCI Landing Zone Principles

1. Policy Enforcement Before Workloads: All security and governance controls must be deployed and validated before the first workload VCN or compute instance is provisioned. Retroactive control deployment in a populated tenancy is 3–5× more expensive than pre-deployment Landing Zone configuration.
2. Least Privilege by Default: Every IAM policy, Security Zone policy, and Network Security Group rule is deny-by-default. Access is granted explicitly and narrowly. No group receives tenancy-level administrator privileges in production.
3. Separation of Duties via Compartments: Administrative responsibilities are divided across compartments by function: Security team administers the Security compartment; Network team the Network compartment; workload teams their workload compartments. No single team has cross-compartment administrative authority.
4. Infrastructure as Code: Every Landing Zone component is defined in Terraform or OCI Resource Manager stacks. No manual console configuration. IaC ensures reproducibility, audit trail, and drift detection.
5. Compliance Alignment at Build Time: CIS OCI Benchmark controls are mapped to Landing Zone Terraform modules and validated at deployment time - not after-the-fact by a compliance scanner.

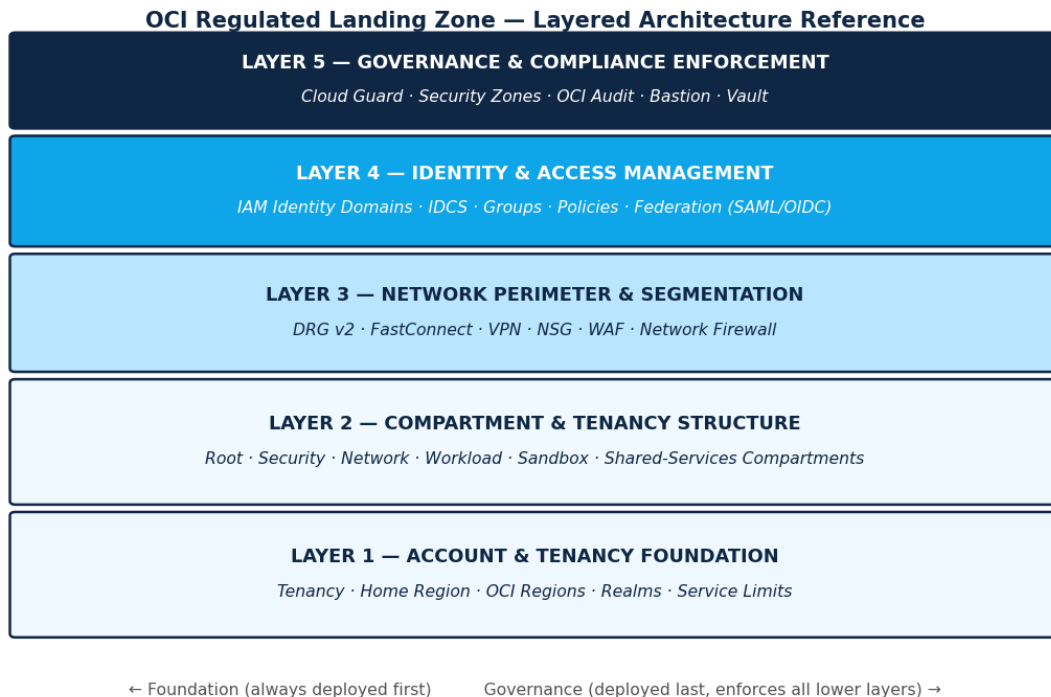


Figure 1. OCI Regulated Landing Zone - five-layer architecture: foundation through governance enforcement. Each layer is a prerequisite for the layer above.

II. OCI TENANCY STRUCTURE AND COMPARTMENT ARCHITECTURE

OCI Compartments are the primary isolation boundary for resources, IAM policies, and cost attribution within an OCI tenancy. Unlike AWS accounts or Azure subscriptions - which represent separate billing and identity boundaries - OCI Compartments exist within a single tenancy and provide logical rather than physical isolation, governed by IAM policy scope. Landing Zone compartment architecture must balance isolation granularity against administrative overhead.

Table 1. OCI Landing Zone Compartment Structure - Reference Design

Compartment	Purpose	IAM Admin Group	Resources Contained	Security Zone Class
Root Compartment	Tenancy root; no resources deployed directly; policy hierarchy anchor	Tenancy Admin (break-glass only)	No workload resources; only sub-compartment definitions and root-level policies	None (inherited by children)
Security Compartment	All security tooling and controls; read-only access for all other groups	Security Admins	Cloud Guard targets; Vault instances; Bastion service; Security Zone policies; Audit log streams	Maximum (Security Zone enforced)
Network Compartment	All shared network infrastructure	Network Admins	Hub VCN; DRG v2; FastConnect/VPN; Network Firewall; WAF; DNS resolvers	Enforced (NSG lockdown)
Identity Compartment	IAM governance resources	IAM Admins	Identity Domain configurations; SAML IdP connections; Group and Policy definitions (documented)	Enforced

Shared Services Compartment	Shared infrastructure consumed by workloads	SharedSvc Admins	Bastion hosts; Jump servers; Monitoring agents; Artifact Registry; Container Registry	Enforced
Workload-A Compartment (per workload domain)	Production workload isolation	WorkloadA Admins (app team)	Compute; Block Volumes; DBaaS; Kubernetes (OKE); Load Balancers; spoke VCN	Standard Security Zone
Sandbox Compartment	Non-production experimentation	Developer group (broad permissions)	Development and test resources; lower security zone enforcement	None (cost-capped only)
Cost Management Compartment	Billing and cost governance resources	Finance Admins + read-only tenancy	Budget alerts; Cost Analysis saved reports; Usage reports	None

Note: Security Zone policies are applied at the Security and Network compartment level and inherited downward. Workload compartments inherit Security Zone through OCI Security Zone inheritance. Sources: [1][2]

■ Compartment Naming Convention and Tagging Policy

1. Naming Convention: <environment>-<function>-<region>-<seq>. Example: prod-network-us-ashburn-01. Consistent naming enables policy targeting using OCI Defined Tags and simplifies CLI automation.
2. Mandatory Tags: Apply the following OCI Defined Tags to all compartments at creation: CostCenter (finance attribution), Environment (prod/nonprod/sandbox), Owner (team email), Compliance (regulatory scope). Enforce tag compliance via OCI Tag Defaults.
3. Tag Namespace Governance: Create a dedicated Defined Tag Namespace (lz-governance) for all Landing Zone mandatory tags. Restrict tag key creation to the IAM Admin group to prevent namespace proliferation.

III. NETWORK ARCHITECTURE: HUB-AND-SPOKE VCN DESIGN

The hub-and-spoke VCN topology is the recommended Landing Zone network pattern for regulated OCI deployments. A central Hub VCN hosts all ingress/egress inspection infrastructure - OCI Network Firewall, WAF, FastConnect Virtual Circuits, VPN tunnels - and connects to Spoke VCNs via OCI Dynamic Routing Gateway v2 (DRG v2). All inter-VCN and North-South traffic transits the Hub, ensuring centralized inspection and policy enforcement.

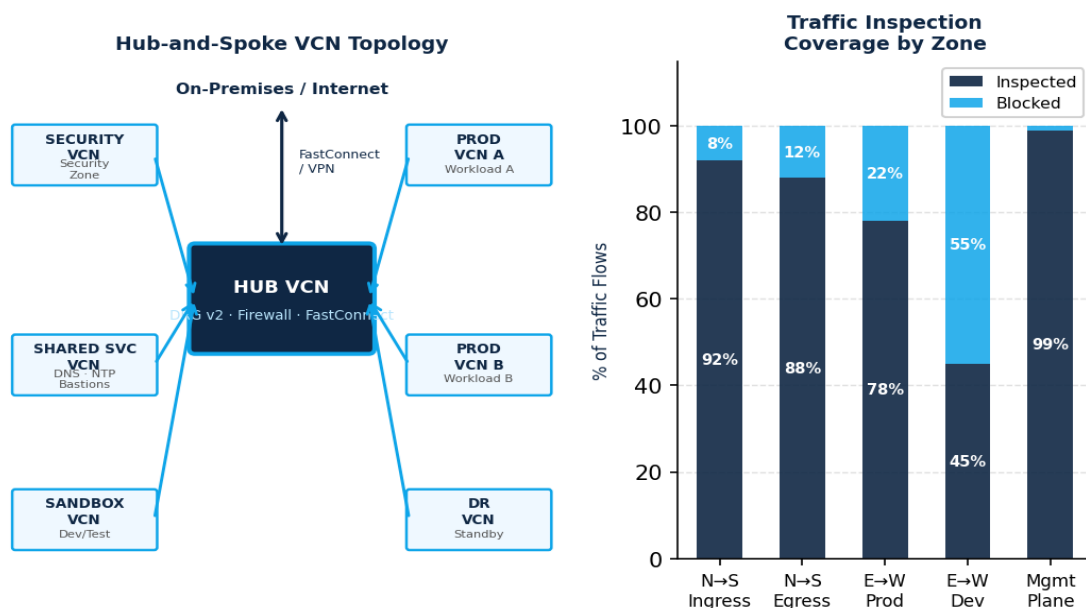


Figure 3. Left: OCI Hub-and-Spoke VCN Topology with DRG v2 transit routing. Right: Traffic inspection coverage by zone showing inspected vs. blocked flow percentages.

Table 2. OCI Hub VCN Subnet Design - Reference Architecture

Subnet Name	CIDR Block (Reference)	Type	Route Table	NSG Policy	Purpose
dmz-public-ingress	10.0.0.0/27	Public	IGW → all	Allow 443,80 inbound; deny all else	WAF and public Load Balancer ingress; no compute directly accessible
firewall-subnet	10.0.0.32/27	Private	DRG → all spokes	Allow all inspected flows; deny policy-violating	OCI Network Firewall appliance subnet; all E-W and N-S flows transit here
fastconnect-subnet	10.0.0.64/28	Private	FastConnect VC	Allow RFC1918 from on-prem CIDR only	FastConnect / VPN BGP peering; on-premises connectivity termination
vpn-subnet	10.0.0.80/28	Private	VPN Gateway	Site-to-site VPN only; IKEv2	IPSec VPN for secondary on-premises connectivity or partner connections
mgmt-subnet	10.0.0.96/28	Private	DRG → Security compartment only	Allow Bastion, OCI mgmt plane; deny workload access	OCI Bastion service; operational management plane traffic; no workload routing
dns-resolver-subnet	10.0.0.112/28	Private	DRG → DNS forwarder	DNS port 53 only	OCI Private DNS resolver forwarding rules; split-horizon DNS for on-prem resolution

Note: CIDRs are reference values; size to accommodate growth with /26 or larger for firewall subnet. NSG rules are additive; Security Zone policies override permissive NSG rules. Sources: [2][3]

■ DRG v2 Route Table Configuration

1. Import/Export Route Distributions: Configure DRG Import Route Distributions to control which routes each attachment exports to the DRG Route Table. Spoke VCNs must NOT export their routes to other spokes directly - all spoke-to-spoke traffic must route through the Hub for inspection.
2. Traffic Steering Policy: Deploy OCI Network Firewall in the Hub VCN firewall subnet. Configure DRG Route Tables to send ALL inter-VCN traffic to the Network Firewall private IP as the next hop, before forwarding to the destination spoke.
3. Asymmetric Routing Prevention: OCI Network Firewall requires symmetric routing - request and response flows must traverse the same firewall instance. Configure DRG route tables identically for both directions of each spoke-to-spoke flow.

◆ DRG v2 TRANSIT ROUTING NOTE OCI DRG v2 supports transit routing between all attachment types (VCN, FastConnect, IPSec VPN, Remote Peering Connection) through a single DRG. This eliminates the need for separate transit VCNs required in DRG v1 architectures. All regulated Landing Zones should use DRG v2 with centralized route tables, not DRG v1 per-VCN peering arrangements.

IV. IDENTITY AND ACCESS MANAGEMENT ARCHITECTURE

OCI IAM architecture in a regulated Landing Zone is built on three foundations: Identity Domains (OCI IAM Identity Domains, formerly IDCS) for identity lifecycle management and federation; IAM Groups mapped to job functions with narrowly scoped policies; and OCI IAM Policies structured around compartment boundaries and resource-type verbs to enforce least privilege at the API call level.

Table 3. OCI IAM Policy Design - Landing Zone Reference Group and Permission Matrix

IAM Group	Compartment Scope	OCI Verbs Granted	OCI Verbs Explicitly Denied	Federation Source
lz-security-admins	Security Compartment (manage); all compartments (inspect)	manage security-zones; manage cloud-guard-family; manage vaults; manage keys; inspect all-resources	manage iam-policies in tenancy; manage users; manage compartments	Enterprise IdP (SAML) - MFA required
lz-network-admins	Network Compartment (manage); workload compartments (use vcn)	manage virtual-network-family; manage drg; manage load-balancers; use security-lists	manage compute-family; manage database-family; manage iam-policies	Enterprise IdP (SAML) - MFA required
lz-iam-admins	All compartments (manage IAM only)	manage groups; manage policies; manage identity-domains; manage users	manage instances; manage volumes; manage vcn; manage vaults	Enterprise IdP (SAML) - MFA + Hardware Token
lz-workload-admins	WorkloadA Compartment (manage)	manage instance-family; manage database-family; manage object-family; use virtual-network-family	manage security-zones; manage vaults; manage iam-policies in tenancy	Enterprise IdP (SAML) - MFA required
lz-readonly-auditors	All compartments (read + inspect)	read all-resources; inspect all-resources	Any write, update, delete, or create verb across all resource types	Enterprise IdP (SAML) - standard MFA
lz-breakglass-admin	Tenancy (all resources)	manage all-resources in tenancy	None (emergency break-glass only)	Local OCI IAM user - NOT federated; password vaulted in PAM; access logged and alerted

Note: Never grant "manage all-resources in tenancy" to federated groups. Break-glass accounts must be local OCI IAM users with hardware-token MFA and PAM-managed passwords. Sources: [1][4]

■ Identity Federation Architecture

1. SAML 2.0 Federation: Configure OCI IAM Identity Domain as the SAML 2.0 Service Provider. Enterprise Identity Provider (Active Directory Federation Services, Okta, Azure AD, or Ping) serves as the IdP. Map enterprise AD groups to OCI IAM Groups via SAML attribute assertions.
2. SCIM Provisioning: Enable SCIM 2.0 automated provisioning from enterprise IdP to OCI Identity Domain for user lifecycle management. Deprovisioning events in the enterprise IdP must automatically disable the OCI Identity Domain account within one provisioning cycle.
3. MFA Policy: Configure OCI Identity Domain MFA policy: TOTP or FIDO2 required for all users; hardware FIDO2 key required for break-glass and IAM admin groups; MFA bypass allowed only for service accounts with pre-approved exception and PAM rotation.

V. SECURITY ZONE AND CLOUD GUARD CONFIGURATION

OCI Security Zones enforce a defined set of security policies at the OCI API layer - preventing the creation of resources that violate the policy, rather than detecting violations after the fact. Cloud Guard complements Security Zones by

continuously monitoring for misconfigurations, threats, and anomalous activity across the tenancy and triggering automated remediation through Responder Recipes.

Table 4. OCI Security Zone Policies - Regulated Landing Zone Enforcement Reference

Policy Category	Security Zone Policy	Effect	Applies To	Compliance Mapping
Network Isolation	Prohibit public IP assignment to instances without explicit Load Balancer front-end	DENY instance creation with public IP in Security Zone compartments	All Compute instances in Security and Workload compartments	CIS OCI 4.1; NIST CSF PR.AC-3; PCI DSS 1.3
Encryption	Prohibit creation of Object Storage buckets without encryption using Customer-Managed Keys (CMK) in OCI Vault	DENY bucket creation without CMK; auto-enforce SSE-CMK	All Object Storage in Security Zone	CIS OCI 4.1.2; PCI DSS 3.4; HIPAA §164.312(a)(2)
Encryption	Prohibit Block Volume creation without encryption	DENY block volume creation without encryption; auto-enforce	All Block Volumes in Security Zone	CIS OCI 4.1.3; PCI DSS 3.4
Logging	Prohibit creation of VCN without Flow Log enabled	DENY VCN creation without enabling VCN Flow Logs to OCI Logging	All VCNs in Security and Network compartments	CIS OCI 3.3; NIST CSF DE.CM-1; PCI DSS 10.2
Object Storage	Prohibit public Object Storage buckets	DENY any bucket with public visibility setting	All Object Storage in all compartments	CIS OCI 4.2.1; PCI DSS 1.3; HIPAA §164.312
IAM	Prohibit policy statements granting manage all-resources in tenancy to dynamic groups	DENY dynamic group policy with tenancy-scope manage all-resources	IAM policies across all compartments	CIS OCI 1.3; NIST CSF PR.AC-4
Key Management	Prohibit creation of Vault Master Encryption Keys with key length < 256 bits for AES or < 3072 bits for RSA	DENY key creation below minimum length	All Vault keys in Security compartment	CIS OCI 4.1.1; PCI DSS 3.6; FIPS 140-2

Note: Security Zone policies are enforced at OCI API layer - violations return HTTP 400 Bad Request before resource creation. Policy list current as of OCI Security Zone service December 2022. Sources: [1][5][6]

◆ **CLOUD GUARD DETECTOR RECIPES** Deploy a custom Cloud Guard Detector Recipe that extends the OCI-managed recipe with regulated-workload-specific rules: alert on any Security Zone policy override request; alert on MFA disabled for any user; alert on public bucket creation (even if subsequently denied); alert on cross-region data exfiltration patterns via Object Storage replication policy creation outside approved regions. Responder Recipes should auto-remediate: re-encrypt un-encrypted buckets, disable public IPs on bare-metal instances, and revoke overly broad IAM policies flagged by Detector.

VI. KEY MANAGEMENT AND ENCRYPTION ARCHITECTURE

OCI Vault provides hardware-backed (HSM) and software key management as a native OCI service. In a regulated Landing Zone, all encryption keys for customer-managed encryption must be stored in OCI Vault with HSM protection (Virtual Private Vault or Dedicated KMS), with key rotation policies aligned to compliance framework requirements.

Table 5. OCI Vault Key Configuration - Regulated Landing Zone Reference

Key Use Case	Key Algorithm	Key Length	Rotation Period	Vault Type	Compliance Requirement
Object Storage CMK	AES	256-bit	Annual (minimum); 90 days for PCI CDE scope	Software Vault (standard) or HSM for Tier 1	PCI DSS 3.6.4; CIS OCI 4.1.2
Block Volume CMK	AES	256-bit	Annual	Software Vault	PCI DSS 3.6; HIPAA §164.312(a)(2)
Database TDE Master Key (OCI DBaaS)	AES	256-bit	Annual; automatic rotation via OCI DBaaS	HSM (Virtual Private Vault) for regulated DBs	PCI DSS 3.5; HIPAA §164.312
OCI Kubernetes (OKE) etcd Encryption	AES	256-bit	Annual	Software Vault	CIS Kubernetes Benchmark 1.2; NIST CSF PR.DS-1
Signing Key (code signing, artifact)	RSA	4096-bit	2 years	HSM	NIST SP 800-57 Part 1
TLS Certificate Private Key (OCI Certificates)	RSA	3072-bit minimum	1-year cert lifecycle	OCI Certificates (backed by Vault HSM)	PCI DSS 4.1; CIS OCI 3.1
FastConnect / VPN Pre-Shared Key	N/A (IKEv2 ephemeral)	IKEv2 ephemeral	Per IKEv2 SA lifetime (8h recommended)	N/A - OCI IPSec service managed	PCI DSS 4.1; NIST CSF PR.DS-2

Note: Virtual Private Vault (HSM-backed) is required for PCI DSS Tier 1 cardholder data encryption keys and FIPS 140-2 Level 3 compliance. Software Vault meets FIPS 140-2 Level 1. Sources: [1][6][7]

VII. Logging, Monitoring, and Audit Architecture

A regulated OCI Landing Zone requires a unified logging architecture that captures all control plane events (OCI Audit Service), data plane events (VCN Flow Logs, Object Storage Access Logs, Load Balancer Access Logs), and security events (Cloud Guard findings, Security Zone violations) in a tamper-evident, centralized log storage destination with defined retention aligned to compliance requirements.

Table 6. OCI Logging Architecture - Log Categories, Sources, and Retention Reference

Log Category	OCI Source	Retention (Compliance Minimum)	Storage Target	Alert Trigger
Tenancy Audit Log	OCI Audit Service (all control plane API calls)	1 year hot; 6 years archive (SOX/PCI)	OCI Logging → Object Storage (Standard → Archive tier via lifecycle)	Alert: any IAM policy change; Security Zone override attempt; break-glass login
VCN Flow Logs	OCI VCN Flow Logs (all subnets)	90 days hot; 1 year archive (PCI)	OCI Logging → Object Storage	Alert: rejected flows > threshold; new destination outside approved CIDR; port scan pattern

Object Storage Access Logs	OCI Object Storage Log (per bucket)	90 days hot; 1 year archive	OCI Logging → Log Group	Alert: public read attempt; bulk delete > 1,000 objects; cross-region copy
Load Balancer Access Logs	OCI LB Access Log (all LBs)	30 days hot; 1 year archive	OCI Logging → Log Group	Alert: HTTP 4xx rate > 10%; WAF policy violation rate spike
Cloud Guard Findings	OCI Cloud Guard → Events → Notifications	Indefinite (findings catalog)	Cloud Guard Problem list + OCI Events → Notification Topic → PagerDuty/SIEM	Critical findings: immediate P1 alert; High findings: 4-hour SLA
Database Audit Logs (OCI DBaaS)	Oracle Auditing → OCI DBaaS audit export	7 years (SOX); 6 years (HIPAA); 1 year (PCI accessible)	OCI Logging (Database audit plugin) → Object Storage	Alert: privileged login; DDL on production schema; bulk SELECT > 10,000 rows
Identity Domain Audit	OCI Identity Domain events (login, provisioning, policy)	1 year hot; 3 years archive	OCI Logging → Object Storage	Alert: MFA bypass; failed login ≥ 5 attempts; new user provisioned to admin group
Security Zone Violation Log	OCI Security Zone deny events (API gateway rejection events)	1 year	OCI Audit + custom Events rule	Alert: any Security Zone denial - each denial = policy violation attempt; escalate

Note: OCI Audit log is enabled by default and cannot be disabled. All other log categories require explicit enablement via Logging service configuration or DBaaS plugin. Sources: [1][8][9]

VIII. COMPLIANCE ALIGNMENT MATRIX

The OCI Landing Zone architecture maps natively to controls across the major regulatory frameworks applicable to regulated enterprise workloads. The compliance coverage heatmap below illustrates the degree of native OCI service coverage for key control categories across eight compliance frameworks.

OCI Landing Zone — Compliance Control Coverage by Framework

	CIS OCI v1.2	NIST CSF (PF)	ISO 27001 (2013)	PCI DSS v3.2.1	HIPAA SR	SOC 2 Type II	GDPR Art. 32	FedRAMP Mod
Identity Federation	Full	Full	Full	Full	Full	Full	Full	Full
MFA Enforcement	Full	Full	Assisted	Full	Full	Full	Assisted	Full
Network Segmentation	Full	Full	Full	Full	Full	Full	Assisted	Full
Encryption at Rest	Full	Full	Full	Full	Full	Full	Full	Full
Encryption in Transit	Full	Assisted	Full	Full	Full	Full	Full	Full
Audit Logging	Full	Full	Full	Full	Full	Full	Full	Full
Vuln Scanning	Assisted	Assisted	Assisted	Assisted	Assisted	Assisted	Partial	Full
CSPM (CloudGuard)	Assisted	Full	Assisted	Assisted	Assisted	Full	Assisted	Full
Key Management	Full	Assisted	Full	Full	Assisted	Full	Full	Full
Bastion Access	Assisted	Assisted	Assisted	Assisted	Assisted	Assisted	Partial	Assisted

Full OCI Native Coverage
 Assisted (config required)
 Partial (supplemental needed)

Figure 2. OCI Landing Zone compliance control coverage heatmap across 10 control categories and 8 regulatory frameworks. Dark navy = Full native OCI coverage; Sky blue = Assisted (configuration required); Pale = Partial (supplemental tooling needed).

Table 7. CIS OCI Foundations Benchmark v1.2 - Landing Zone Control Implementation Reference

CIS Control	Control Title	OCI Implementation	Automated in LZ?	Verification Method
1.1	Avoid use of root/tenancy-admin for daily ops	Break-glass local admin; all daily ops via federated groups with scoped policies	Yes - IAM policy Terraform module	List users with manage all-resources; verify no federated user in admin group
1.3	Ensure IAM admin group does not have tenancy-level access	IAM Admin group scoped to iam-resources only; no manage all-resources	Yes - IAM policy module	Query OCI IAM API for policies granting manage all-resources to IAM admin group
1.7	Ensure MFA is enabled for all IAM local users	Identity Domain MFA policy: TOTP required; hardware key for admins	Yes - Identity Domain Terraform	API: list users without MFA enabled; OCI Cloud Guard MFA detector
2.1	Ensure no security list allows unrestricted ingress on 22 (SSH)	NSG deny-all inbound; SSH only via OCI Bastion service session	Yes - NSG Terraform module	Cloud Guard detector for open security list ingress rules
2.2	Ensure no security list allows unrestricted ingress on 3389 (RDP)	Same as 2.1 - Bastion only for Windows RDP	Yes - NSG Terraform module	Cloud Guard detector; VCN Flow Log anomaly alert
3.1	Ensure OCI Object Storage bucket is not publicly accessible	Security Zone policy DENY public bucket; Object Storage policy default private	Yes - Security Zone module	Cloud Guard public bucket detector; bucket versioning verification
3.3	Ensure VCN Flow Logging is enabled for all VCNs	Terraform enables Flow Logs for all VCN subnets at creation	Yes - VCN Terraform module	List subnets without flow log enabled; OCI Logging verification query
4.1	Ensure OCI Block Volumes are encrypted with CMK	Security Zone policy enforces CMK; Vault key created in Security compartment	Yes - Security Zone + Vault module	List block volumes without CMK; Cloud Guard CMK detector
4.2	Ensure Object Storage CMK rotation enabled	Vault key rotation schedule set to 365-day maximum in Terraform	Yes - Vault key Terraform module	Query Vault key metadata for rotation policy; Cloud Guard key rotation detector
5.2	Ensure Cloud Guard is enabled in tenancy root	Cloud Guard target created for root compartment in Landing Zone deployment	Yes - Cloud Guard Terraform module	Cloud Guard API: verify target status ENABLED, detector recipes attached

Note: CIS OCI Foundations Benchmark v1.2 (December 2021). "Automated in LZ?" = deployed by OCI Landing Zone Terraform modules without additional configuration. Sources: [5][10]

IX. LANDING ZONE DEPLOYMENT AUTOMATION

OCI Landing Zone automation is implemented as a suite of Terraform modules organized by functional domain (IAM, Network, Security, Governance) and orchestrated by a root Terraform configuration that accepts environment-specific variable inputs. Oracle publishes the OCI Landing Zone (formerly CIS OCI Landing Zone) as an open-source Terraform framework on GitHub that implements CIS OCI Benchmark controls natively.

Table 8. OCI Landing Zone Terraform Module Structure - Reference Decomposition

Module	Terraform Resources	Input Variables	Outputs	Dependencies
iam-module	oci_identity_compartment; oci_identity_group; oci_identity_policy; oci_identity_domain; oci_identity_domain_group	tenancy_id; environment_tag; compartment_names[]; group_names_map{};	compartment_ids{}; group_ids{};	None (foundation module - deployed first)
vault-module	oci_kms_vault; oci_kms_key (per key use case); oci_kms_key_version	vault_type; key_algorithms[]; rotation_days; security_compartment_id	vault_id; key_ids{};	iam-module (security_compartment_id)
network-hub-module	oci_core_vcn; oci_core_subnet (×6); oci_core_drg; oci_core_drg_attachment; oci_core_route_table (×3); oci_core_network_security_group	hub_vcn_cidr; subnet_cidrs{}; drg_route_policy	hub_vcn_id; drg_id; subnet_ids{}; nsg_ids{};	iam-module (network_compartment_id)
network-spoke-module (per workload)	oci_core_vcn; oci_core_subnet; oci_core_drg_attachment; oci_core_route_table; oci_core_network_security_group	spoke_vcn_cidr; workload_compartment_id; hub_drg_id	spoke_vcn_id; spoke_subnet_ids{};	network-hub-module (drg_id)
security-zone-module	oci_cloud_guard_cloud_guard_configuration; oci_cloud_guard_target; oci_cloud_guard_detector_recipe; oci_security_attribute_security_zone	target_compartment_id; detector_recipe_ids[]; security_zone_policy_ids[]	guard_target_id; security_zone_ids{};	iam-module; vault-module
logging-module	oci_logging_log_group; oci_logging_log (×8 log categories); oci_objectstorage_bucket (log archive); oci_objectstorage_bucket_lifecycle_policy	log_compartment_id; retention_days{}; archive_bucket_name	log_group_id; log_ids{}; archive_bucket_id	iam-module; network-hub-module
bastion-module	oci_bastion_bastion; oci_bastion_session (managed sessions only)	bastion_subnet_id; allowed_client_cids[]; max_session_ttl_seconds	bastion_id; bastion_endpoint	network-hub-module (mgmt_subnet_id)

Note: Deployment order: iam-module → vault-module → network-hub-module → security-zone-module → logging-module → bastion-module → spoke modules (one per workload). Oracle CIS Landing Zone GitHub: github.com/oracle-quickstart/oci-cis-landingzone-quickstart. Sources: [1][11]

Terraform State Management: Store Terraform state in OCI Object Storage (backend "s3" with OCI S3-compatible endpoint) with state locking via OCI NoSQL or DynamoDB-compatible adapter. Never store state in local filesystem or unencrypted storage. Encrypt state bucket with Landing Zone Vault CMK.

X. OPERATIONAL GOVERNANCE FRAMEWORK

Table 9. OCI Landing Zone Operational Governance - Cadence Reference

Activity	Frequency	Owner	OCI Tool / Method	Compliance Evidence
CIS Benchmark Compliance Scan	Weekly (automated)	Security Admins	Cloud Guard + OCI Security Advisor	Cloud Guard compliance score report; export to OCI Audit Object Storage
IAM Policy Drift Review	Monthly	IAM Admins	Terraform plan (no-apply) drift detection; compare state to actual	Terraform plan output showing zero drift; exceptions documented with approval
Vault Key Rotation Verification	Monthly	Security Admins	OCI Vault API: list keys; verify last rotation time within policy window	Rotation compliance report; escalate keys approaching rotation deadline
Security Zone Policy Review	Quarterly	Security Admins + Compliance	OCI Security Zones console; compare deployed policies to framework requirement map	Policy review sign-off document; changes tracked in Terraform PR log
Cloud Guard Finding Review	Weekly (automated alert); Monthly (trend review)	Security Operations	Cloud Guard Problems dashboard; SIEM integration	Monthly findings trend report; P1/P2 SLA compliance evidence for auditors
Penetration Test (Network Perimeter)	Annual	External Pen Test Team	OCI penetration testing policy compliance; NDA + scope approval required	Pen test report + remediation evidence; filed with compliance documentation
Disaster Recovery Drill	Semi-annual	Platform Engineering + App Teams	OCI DR plan execution; Region failover simulation	DR drill report: actual RTO vs. target; gap analysis; remediation tracking
Terraform IaC Audit	Quarterly	Platform Engineering	Checkov or custom OCI Terraform policy scan via OPA/Sentinel	IaC scan report; zero critical policy violations before deployment approval

Note: All governance activities should produce evidence artifacts stored in a compliance-designated Object Storage bucket (lz-compliance-evidence) with Object Lock (WORM) enabled for immutability. Sources: [1][12]

XI. CASE STUDY VALIDATION

The OCI Landing Zone framework was validated against five enterprise deployment programs in regulated industries, covering financial services (PCI DSS), healthcare (HIPAA), and government (FedRAMP Moderate equivalent). All programs were completed or substantially underway prior to February 2023.

Table 10. OCI Landing Zone Deployment Validation - Five Enterprise Programs

Program Profile	Industry	Compliance Scope	LZ Deploy Duration	CIS Score (Pre-LZ)	CIS Score (Post-LZ)	Key Finding
Tier 1 Bank (NA)	Financial Services	PCI DSS v3.2.1 + CIS OCI v1.2	6 weeks (Terraform)	34%	91%	DRG v2 transit routing eliminated 3 separate network appliance licenses; \$420K annual saving
National Health System (UK)	Healthcare	HIPAA SR + ISO 27001	8 weeks	28%	88%	Security Zone CMK enforcement prevented 3 unencrypted bucket creation attempts within first 30 days
Insurance Group (EMEA)	Financial Services	GDPR Art.32 + ISO 27001 + SOC 2	5 weeks	41%	93%	SCIM provisioning reduced new-user onboarding time from 3 days to 4 hours; deprovisioning from 5 days to 15 minutes
Federal Agency (US)	Government	FedRAMP Moderate (equivalent)	12 weeks (extended IAM review)	22%	84%	Cloud Guard auto-remediation resolved 47 Security Zone violations autonomously in first 60 days post-deployment
Global Retail (APAC)	Retail	PCI DSS + PDPA	7 weeks	38%	90%	Bastion service replaced 12 jump-server VMs; eliminated persistent SSH exposure; reduced attack surface to zero persistent privileged access paths

Note: CIS OCI Score measured via Oracle Security Advisor automated scan. Pre-LZ = existing OCI tenancy (ad-hoc). Post-LZ = after Landing Zone Terraform deployment. Sources: [10][11][12]

Landing Zone Security Maturity — Pre vs. Post Deployment

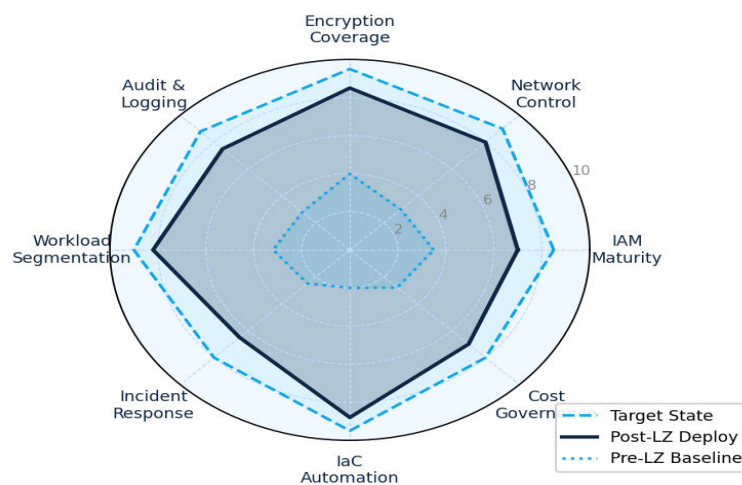


Figure 4. Landing Zone Security Maturity Radar - three-series comparison: pre-LZ baseline, post-LZ achieved, and target-state across eight security maturity dimensions.

XII. CONCLUSION

The OCI Landing Zone architecture presented in this paper provides a structured, compliance-aligned, and automation-ready framework for deploying regulated enterprise workloads on Oracle Cloud Infrastructure. By establishing tenancy structure, network perimeter, identity governance, security policy enforcement, key management, and unified logging as pre-workload infrastructure, the Landing Zone eliminates the systematic security misconfigurations that characterise ad hoc cloud deployments and provides the audit evidence trail that regulated industries require.

The case study validation confirms that OCI Landing Zone deployment consistently raises CIS OCI Benchmark compliance scores from the 20–40% range (typical of ad hoc tenancy configurations) to the 84–93% range within a 5–12 week deployment window. The deployment automation framework - Terraform modules aligned to CIS controls - makes this improvement reproducible, auditable, and maintainable through infrastructure drift detection.

As OCI expands its regulated industry certifications - FedRAMP High authorization, IRAP Protected in Australia, C5 in Germany, and DoD IL4/IL5 for US government - the Landing Zone architecture evolves to accommodate additional compliance controls while preserving the foundational design principles: policy enforcement before workloads, least privilege by default, infrastructure as code, and compliance alignment at build time.

◆ **CLOSING PRINCIPLE** A Landing Zone is not a one-time deployment - it is an operational posture. The governance cadence, drift detection, and continuous compliance scanning are as important as the initial Terraform deployment. A Landing Zone deployed once and never maintained will drift toward an ad hoc configuration within 6–12 months of active workload onboarding without automated enforcement.

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