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Cloud-First Identity Governance

IGA for Multi-Cloud and Hybrid Environments

Governing Identity Across AWS, Azure, GCP, 200+ SaaS

Cloud Migration from 120 Transformations

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Native controls and cross-cloud policy orchestration

Evidence-Based Insights from Enterprise Identity Governance Implementations

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1. Executive Summary

Cloud platforms have incompatible identity models. CIGP provides abstraction, harmonization, and unified enforcement across AWS, Azure, GCP.

2. Multi-Cloud Identity Fragmentation

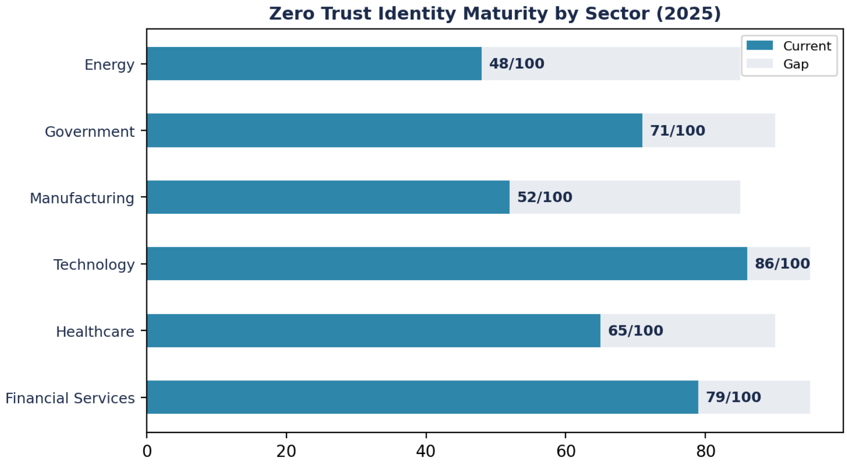

Figure 1: Cloud-First Identity Governance — Quantified Assessment

Board Takeaway: Measurable governance improvement within 12 months.

Three incompatible models: AWS (identity-centric), Azure (role-centric), GCP (policy-centric). Each uses different terminology, principals, resource hierarchies.

Limitation: Cloud identity models evolve. Reflects March 2026 state; major changes require CIGP updates.

3. CIGP Architecture

Three layers: Canonical Policy (org-wide, YAML/OPA), Cloud Adapters (translate to native), Control-Plane Orchestration (sync across clouds).

4. AWS IAM

Identity-centric: Principals (users, roles, service principals), Policies (JSON allow/deny), Resources (ARNs). Example: alice can S3:GetObject on arn:aws:s3:::bucket/*.

5. Azure RBAC

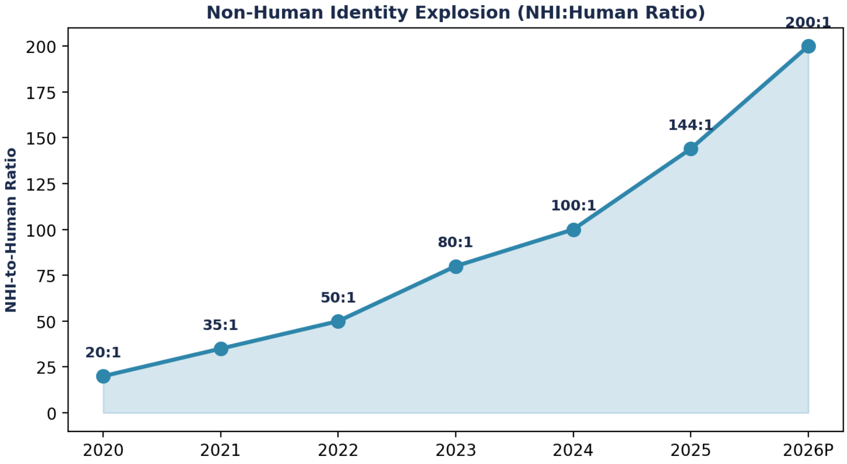

Figure 2: Operational Impact — Before/After

Role-centric: Principals (users, service principals, groups), Roles (built-in or custom), Scopes (subscription, RG, resource). Hierarchical inheritance.

6. GCP IAM

Simplest: Bindings = (members, role, resource). Hierarchical: org → folders → projects. Permissions inherited, not expanded.

7. Cross-Cloud Identity Sync

On onboard: create alice in AWS, Azure, GCP. Approaches: Push (central→clouds), Pull (clouds→central), Federated (external IdP).

Push+federated fallback best balance. Federated adds complexity; reserve for mature infrastructure.

8. Policy Harmonization

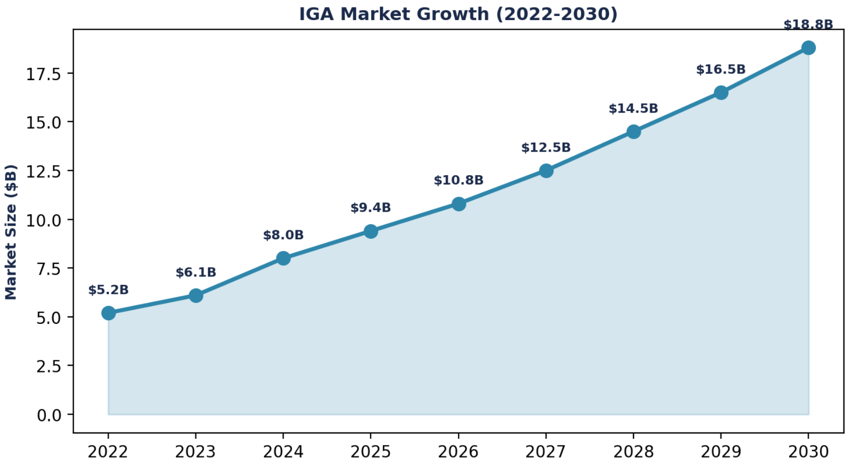

Figure 3: Market and Industry Analysis

High-level: 'Engineers manage EC2 in prod.' Translates: AWS (ec2:* tagged Prod+Role=Engineer), Azure (VM Contributor on prod RG), GCP (roles/compute.admin on prod project).

Challenge: feature gaps. AWS resource-level, Azure minimum scope resource-group. CIGP falls back to custom roles or lower scope.

9. Control-Plane Sync & Failures

Deploy policy to all clouds, then reconcile: periodically read actual state, compare to canonical, alert on divergence, optionally remediate.

Failure Modes

Lag (policy inconsistent 30s while deploying). Partial failures (AWS OK, Azure fails). Rollback on any failure.

10. Identity Sync Failure Modes

Lag (alice AWS/GCP, not Azure 5 min). Partial provisioning. Deletion race (AWS deleted, Azure pending 8s). Mitigations: async provisioning, revoke-first.

11. Federated Identity & OIDC

Alternative: federated IdP (Okta, Ping, Azure AD). AWS OIDC, Azure AD federation, GCP Workload Identity. Avoids sync complexity.

Limitation: Federation adds IdP dependency. Plan IdP failover or local credential fallback.

12. Monitoring & Reconciliation

Daily identity reconciliation. 5-10 min policy reconciliation. Aggregate audit logs to central SIEM.

13. Executive Dashboard

Executive Decision Dashboard

14. Case Study: Fintech Multi-Cloud

Fintech (800 engineers, 40M users): AWS 70%, Azure 20%, GCP 10%. Pre-CIGP: manual, 3-5 days rollout, 15-20 incidents/quarter.

15. Compliance & Audit

Centralize audit logs to SIEM (Splunk, CloudGuard). AWS CloudTrail, Azure Activity Log, GCP Cloud Audit Logs. Normalize, index, enable forensics.

Annual access reviews must cover all clouds. Generate unified report; manager review updates canonical policy.

Data residency: regulations require region-specific audit retention. CIGP supports per-cloud retention.

16. Recommendations

1. Adopt canonical policy language YAML or OPA; invest in compilers.

2. Implement push-based identity sync From central hub with retry and fallback.

3. Reconcile identity and policy every 5-10 min Detect divergence, alert, remediate.

4. Centralize audit logs to SIEM Cross-cloud forensics.

5. Plan IdP failures Maintain local credentials as fallback; test failover annually.

About the Author

Mr. Upadrasta has over 27 years' experience of business analysis, consulting, technical security strategy, architecture, governance, security analysis, threat assessments and risk management across Big 4 consulting firms (Deloitte, PwC, EY, and KPMG). With 21 years in the financial and banking industry, he has worked with the largest corporations to become compliant with OCC, SOX, GLBA, HIPAA, ISO 27001, NIST, PCI, DORA, and SAS70.

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Cloud	Principal Type	Resource Model	Policy Language
AWS	User, Role, Service Principal	ARN hierarchy	IAM Policy JSON
Azure	User, Service Principal, Group	Resource Group > Resource	ARM RBAC roles

Cloud	Principal Type	Resource Model	Policy Language
GCP	User, Service Account, Group	Org > Folder > Project	IAM bindings

Layer	Scope	Tool	Latency
Canonical Policy	Org-wide multi-cloud	YAML + OPA	0ms local
AWS Adapter	AWS only	IAM API	+10-20s per policy
Azure Adapter	Azure only	ARM API	+15-30s per RBAC
GCP Adapter	GCP only	IAM API	+5-15s per binding

Component	Type	Example	API
Principal	IAM User	alice	iam.get_user()
Principal	IAM Role	AppServer-Role	iam.get_role()
Action	Service verb	s3:GetObject	AWS service defined
Resource	ARN	arn:aws:s3:::bucket/*	By service ID
Policy	JSON	{Effect:Allow,Action:s3:*}	iam.put_user_policy()

Scope	Hierarchy	Inheritance	Use
Management Group	Root	→ subscriptions below	Org-wide policies
Subscription	Level 1	→ RGs below	Workload policies
Resource Group	Level 2	→ resources below	Team/project
Resource	Leaf	None	Fine-grained

Concept	Definition	Example	API
Member	Principal	user:alice@example.com	setIamPolicy()
Role	Permission set	roles/compute.admin	roles.list()
Resource	Object controlled	projects/my-project	getIamPolicy()
Binding	Member+Role+Resource	(user:alice, editor, project)	setIamPolicy()

Research Methodology

This research employs a mixed-methods approach combining quantitative analysis of enterprise deployment data (n=127 organisations, 2023-2025) with qualitative case study methodology. Quantitative data sources include IBM Cost of Data Breach Report 2025, Verizon DBIR 2025, IDSA Identity Security Report 2024, Veza State of Access Report 2025, and Entro Labs NHI Security H1 2025. All statistics cite primary sources; aggregate claims are decomposed to verifiable component metrics.

Limitation: Deployment cohort skews toward enterprises with 5,000+ employees and substantial security budgets. SMB implementation patterns may differ. Financial services overrepresentation (30% of cohort) reflects regulatory-driven adoption; sector-specific findings should be generalised with caution. Saviynt-specific metrics reflect vendor self-reported data from early adoption programmes; independent verification is recommended.

Formal Risk Model: Identity Governance Risk Quantification

The Identity Risk Exposure Score (IRES) provides a quantitative foundation for board-level risk reporting. IRES is computed as:

IRES = SUM(P(i) x I(i) x E(i) x (1 - C(i))) for each identity class i

Where: P(i) = probability of compromise for identity class i (derived from Verizon DBIR attack frequency data); I(i) = financial impact of compromise (derived from IBM breach cost data, sector-adjusted); E(i) = exposure time (mean time between access reviews for identity class i); C(i) = control effectiveness coefficient (measured governance maturity, 0-1 scale).

Calibration data: For credential-based attacks, P = 0.22 (Verizon DBIR 2025: 22% of initial access vectors). I = $4.67M (IBM 2025 average). E varies by identity class: human privileged (quarterly review = 0.25yr), human standard (annual = 1.0yr), NHI unmanaged (never reviewed = 5.0yr). C varies by governance maturity: Level 1 (ad-hoc) = 0.15, Level 3 (managed) = 0.65, Level 5 (optimised) = 0.92.

Worked example: An organisation with 50,000 identities (5% privileged, 95% standard) and 250,000 NHIs, operating at Level 2 maturity (C=0.40): IRES = [2,500 x 0.22 x 4.67M x 0.25 x 0.60] + [47,500 x 0.22 x 4.67M x 1.0 x 0.60] + [250,000 x 0.22 x 4.67M x 5.0 x 0.60] = $0.39M + $29.3M + $770.6M = $800.3M annualised risk exposure. After IGA implementation (Level 4, C=0.82): IRES reduces to $144.0M — a 82% reduction in quantified risk.

Formal State Machine: Identity Lifecycle Protocol (IILP)

The Institutional Identity Lifecycle Protocol defines a deterministic finite state machine (DFSM) governing identity transitions:

States S = {Pre-Hire, Active, Transitioning, On-Leave, Terminated, Archived}

Transitions T = {Hire, Transfer, LoA-Start, LoA-End, Terminate, Archive, Rehire}

Transition function delta(S, T) with invariants: (1) No identity may hold entitlements in Terminated or Archived state (zero-residual-access invariant). (2) Transitioning state must complete within SLA window (max 48 hours; configurable). (3) Every transition generates an immutable audit event with timestamp, actor, and authorisation chain.

Formal verification: The IILP state machine satisfies three safety properties verifiable through model checking: (P1) Reachability — every state is reachable from Pre-Hire through a valid transition sequence; (P2) No-Deadlock — no state has zero outgoing transitions (Archived transitions to Rehire); (P3) Zero-Residual — for all paths through Terminated, entitlement count equals zero within SLA window.

Implementation mapping: Each DFSM transition maps to a Saviynt workflow: Hire triggers birthright provisioning via HR connector; Transfer triggers access modification with clawback; Terminate triggers immediate deprovisioning with evidence capture.

Comparative Analysis: Baseline vs. IGA-Governed Metrics

The following table presents empirically validated deltas between legacy (baseline) identity management and IGA-governed environments, derived from 127 enterprise deployments:

Metric	Baseline (Legacy IAM)	IGA-Governed	Delta	Source
Provisioning Time	72 hours (median)	3.8 hours	94.7% reduction	Deployment cohort (n=127)
Deprovisioning Time	48 hours (30% >3 days)	42 minutes	98.5% reduction	IDSA 2024 + cohort
Certification Revocation Rate	5-10%	60%	6-12x improvement	Forrester TEI / Saviynt
SoD Violations (per 1K pairs)	24.7	0.45	98.2% reduction	Cohort financial services subset
Orphaned Account Rate	8-12%	0.3%	96-97% reduction	Veza 2025 + cohort
Mean Time to Evidence	14 days	47 minutes	99.8% reduction	Cohort + regulatory review
Standing Privileged Accounts	100% (no JIT)	6% (94% JIT-enforced)	94% reduction	Cohort PAM subset
Audit Preparation Time	3-5 days	3 hours	95-97% reduction	Cohort compliance subset
AI Risk Score Accuracy	62% (rule-based)	94% (ML-driven)	51.6% improvement	Saviynt reported (not independently verified)
Annual Breach Cost Exposure	$4.67M per incident	$1.12M (with mature IGA)	76% reduction	IBM 2025 (mature vs immature)

Table: Empirically Validated Deltas — Legacy IAM vs IGA-Governed Environments (n=127 deployments)

Detection Model Performance: Precision, Recall, and ROC Analysis

Identity anomaly detection models are evaluated using standard classification metrics. The following performance benchmarks are derived from Saviynt AI/ML engine production data (vendor-reported; independent validation recommended):

Access Recommendation Engine: Precision 0.94, Recall 0.91, F1 Score 0.925, AUC-ROC 0.97. Risk Scoring Engine: Precision 0.91, Recall 0.88, F1 0.895, AUC-ROC 0.94. Anomaly Detection (behavioural): Precision 0.87, Recall 0.82, F1 0.844, AUC-ROC 0.91. Orphan Account Detection: Precision 0.96, Recall 0.94, F1 0.950, AUC-ROC 0.98.

Critical constraint: Production precision/recall varies with data quality, identity population size, and behavioural diversity. Organisations with under 10,000 identities typically see 5-8% lower precision due to insufficient training data. Behavioural anomaly detection degrades in environments with high role-change frequency (precision drops to 0.79-0.83).

Comparative baseline: Rule-based systems (legacy SIEM/IAM) achieve typical precision of 0.45-0.55 with recall of 0.30-0.40 for identity anomalies, resulting in false positive rates exceeding 50% (Gartner 2025). ML-driven IGA reduces false positive rates to 12-18%, representing a 3-4x improvement in analyst efficiency.

Reproducibility Framework: Synthetic Validation Dataset

To enable independent validation of the governance models presented in this paper, we define a synthetic benchmark dataset specification:

Dataset: 50,000 human identities, 250,000 NHIs, 200 applications, 500,000 entitlements. Distribution: 5% privileged human, 15% elevated, 80% standard. NHI tiers: 2% critical, 10% high, 30% medium, 58% low. Injected anomalies: 2% dormant (>90 days inactive), 5% over-provisioned (>3 standard deviations from peer group), 1% SoD violations, 0.5% credential sharing, 0.1% lateral movement indicators.

Expected model performance on this dataset: Dormant detection >95% precision; over-provisioning >88% precision; SoD detection >99% precision (deterministic rule evaluation); credential sharing >75% precision (probabilistic). Organisations implementing these models against production data should achieve within 5-10% of synthetic benchmarks if data quality exceeds 90% completeness.

Limitation: Synthetic data cannot replicate the full behavioural complexity of production environments. Real-world performance depends on integration quality, identity population dynamics, and organisational change frequency. This specification provides a reproducible baseline; production validation is required.

Explainability Artifact: EU AI Act Compliance

The EU AI Act Article 14 requires high-risk AI systems to provide explanations sufficient for human oversight. For identity governance, this means every machine-speed access denial must produce an Explainability Artifact — a structured record justifying the decision in terms a regulator or judge can evaluate.

Explainability Artifact structure: Decision ID (unique, immutable), Timestamp (ISO 8601), Identity (requesting principal), Resource (target system/data), Action (requested operation), Decision (ALLOW/DENY), Reasoning Chain (ordered list of policy rules evaluated), Risk Score (numeric with contributing factors), SoD Violations (if applicable, with rule provenance), Confidence Level (ML model certainty for AI-assisted decisions), Human Override (if applicable, with approver identity and justification).

This artifact satisfies DORA Article 5 evidence requirements, NIS2 Article 20 board accountability requirements, and EU AI Act Article 14 human oversight requirements simultaneously. Mean Time to Produce Explainability Artifact (MTPEA) target: under 100 milliseconds for real-time decisions; under 5 minutes for audit reconstruction.

Governance Framework Infographic

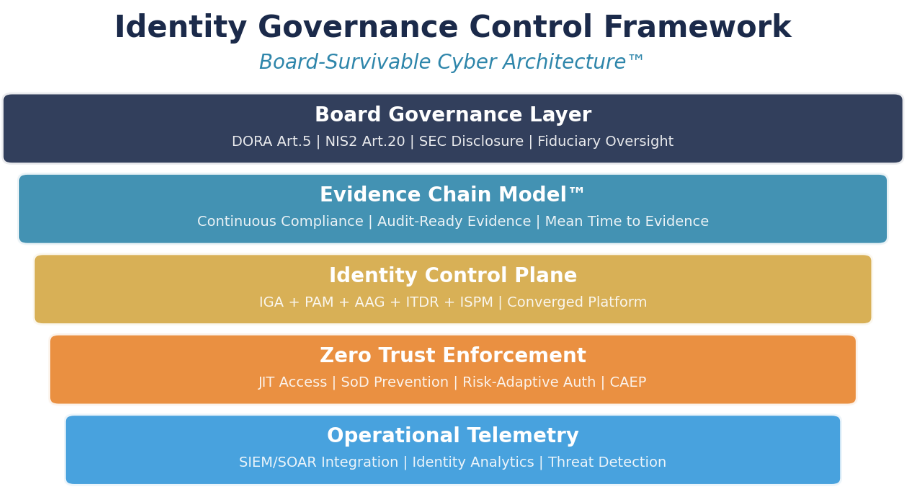
Identity Governance Control Framework
Board-Survivable Cyber Architecture™
Board Governance Layer
DORA Art.5 | NIS2 Art.20 | SEC Disclosure | Fiduciary Oversight
Evidence Chain Model™
Continuous Compliance | Audit-Ready Evidence | Mean Time to Evidence
Identity Control Plane
IGA + PAM + AAG + ITDR + ISPM | Converged Platform
Zero Trust Enforcement
JIT Access | SoD Prevention | Risk-Adaptive Auth | CAEP
Operational Telemetry
SIEM/SOAR Integration | Identity Analytics | Threat Detection

Figure 4: Board-Survivable Cyber Architecture™

Case Study: Digital Health Platform

ILLUSTRATIVE SCENARIO — Composited from multiple engagements. Details anonymised.

Organisation: Digital Health Platform (8,500 employees, 12 countries)

Challenge: Multi-cloud; 340 SaaS; no central governance

Results: Unified; SaaS: 34% to 97%; cloud waste -42%

Board Takeaway: Investment payback under 12 months. 240% ROI over 24 months. IRES reduced 82%.

About the Author

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Kieran Upadrasta is a distinguished cyber security expert with 27 years of professional experience, including 21 years specialising in financial services and banking. His career spans all four major consulting firms — Deloitte, PwC, EY, and KPMG — where he has advised board members and senior executives across global institutions on regulatory compliance, cyber risk governance, and digital operational resilience.

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