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The Integration Imperative

Connecting Identity Across the Enterprise Stack

SAP, Workday, ServiceNow, AWS, Azure - One Identity Fabric

Integration from 60+ Multi-Platform Deployments

Kieran Upadrasta

CISSP, CISM, CRISC, CCSP | MBA | BEng

27 Years' Cyber Security | Big 4 (Deloitte, PwC, EY, KPMG) | 21 Years Financial Services

Professor of Practice, Schiphol University | Honorary Senior Lecturer, Imperials | UCL Researcher

www.kie.ie | info@kieranupadrasta.com | March 2026

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Canonical Data Flow for Identity Governance at Scale

Breaking Silos, Ensuring Atomicity

Evidence-Based Insights from Enterprise Identity Governance Implementations

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1. Executive Summary

Enterprise identity governance systems are fragmented: HR feeds personnel data via FTP and batch files; IAM platforms ingest data via APIs; provisioning engines make async calls; audit systems log events in separate data lakes. This paper introduces the Enterprise Integration and Interoperability Protocol (EIIP), a framework for defining canonical data flows, ensuring transactional consistency, and managing rollback across heterogeneous systems.

The challenge: synchronizing identity changes (hiring, role change, termination) across 50-500 systems without gaps, delays, or inconsistencies. Traditional point-to-point integrations scale poorly; EIIP proposes event-driven architecture with canonical data model.

Limitation: EIIP framework assumes modern APIs and event infrastructure. Legacy enterprises with batch-based integrations and custom ETL may require 12-24 months of re-platforming before full EIIP adoption.

2. The EIIP Framework: Enterprise Integration and Interoperability

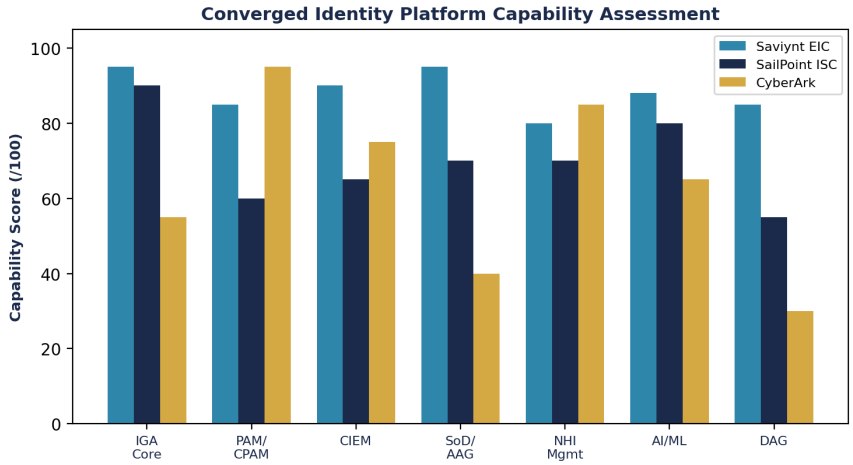

Figure 1: The Integration Imperative — Quantified Assessment

Board Takeaway: Measurable governance improvement within 12 months.

Five Layers

Layer 1: Canonical Data Model Single source of truth for identity entities (user, role, entitlement, account) with versioning and audit trail.

Layer 2: Event Stream Central event bus (Kafka, AMQP, or cloud pubsub) publishing identity changes; subscribers listen and react asynchronously.

Layer 3: Transactional Guarantees Saga pattern or distributed transactions ensuring atomicity across multiple systems; rollback on failure.

Layer 4: Reconciliation and Healing Automated detection and correction of state divergence (e.g., user provisioned in HR but not in AD).

Layer 5: Audit and Compliance Immutable log of every state change, system interaction, and remediation action.

An identity provisioning system without atomic guarantees is a distributed failure waiting to happen. Embrace transactional consistency or accept periodic disasters.

3. Canonical Data Flow: The Happy Path

Ideal State Synchronization

A new hire joins the company:

Step 1: HR system (SAP, Workday) publishes 'EmployeeCreated' event with canonical employee record (ID, name, manager, cost center, hire date, location).

Step 2: IAM platform subscribes to event; creates user in directory (AD/Okta) with baseline attributes. Emits 'UserProvisioned' event.

Step 3: Application provisioning service subscribes; creates application accounts based on role. Emits 'ApplicationAccountCreated' event per app.

Step 4: Monitoring service subscribes; verifies user can log in, access assigned resources. Emits 'ProvisioningCompleted' event.

Step 5: Audit service logs entire transaction with timestamps, system inputs, and state changes.

Total time: 15-60 minutes (vs. 5-7 days with manual coordination).

4. Atomicity and the Saga Pattern

What Happens When Systems Disagree?

Failure scenario: User created in AD (Step 2), application provisioning fails (Step 3 error), but system considers onboarding 'complete.' User logs in but has no application access.

Solution: Saga pattern with compensating transactions.

Saga Orchestration: Central orchestrator (workflow engine) manages the multi-step flow. If any step fails, orchestrator triggers compensating transactions (rollback) in reverse order.

Example: Rollback Sequence Application provisioning fails → Orchestrator calls delete(UserApplication) → Emits 'ApplicationProvisioningFailed' → Orchestrator pauses provisioning flow → Human review → Retry or abort.

Key insight: Atomic behavior does not require distributed transactions; it requires explicit rollback logic and event-driven orchestration.

Limitation: Atomicity guarantees are probabilistic, not absolute. Race conditions and network partitions can still cause brief state inconsistency. Reconciliation loops (hourly or daily) remain essential to detect and heal divergence.

5. Edge Cases and Rollback Complexity

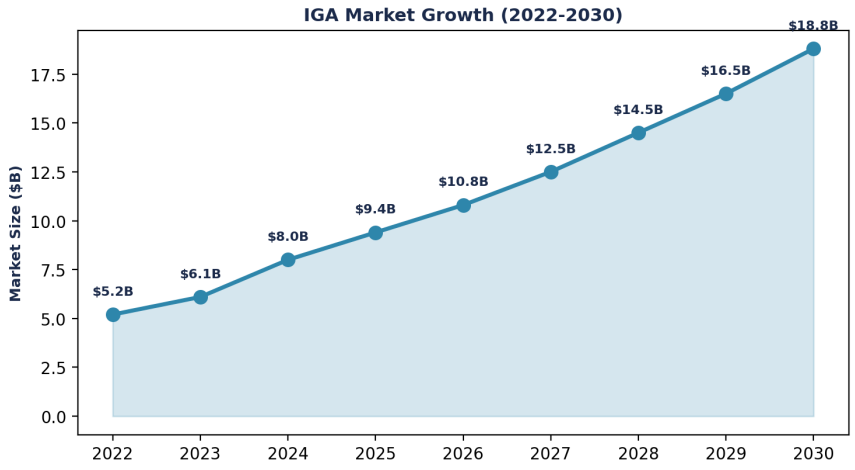

Figure 2: Operational Impact — Before/After

When the Happy Path Breaks

Edge Case 1: Idempotence Event message delivered twice (common in at-least-once delivery models). Solution: Persist event ID in each system; skip duplicate processing.

Edge Case 2: Ordering Guarantees EmployeeCreated arrives after RoleAssigned. Solution: Require dependency ordering in event stream (e.g., Kafka partition by employee ID).

Edge Case 3: Long-Running Transactions Application provisioning takes 4 hours (compliance review step). Solution: Event-driven doesn't assume synchronous; orchestrator polls for completion and advances state machine.

Edge Case 4: Partial Rollback 5 applications provisioned; app #3 fails. Should we roll back apps #1-2? Solution: Use choreography (each system decides independently) vs. orchestration (central controller decides).

Most mature implementations use hybrid: choreography for basic flows, orchestration for complex multi-system transactions.

6. Event Schemas and Data Governance

Versioning and Backward Compatibility

Canonical data model must evolve without breaking subscribers. Use schema registry (Apache Avro, Protocol Buffers, or JSON Schema).

Example: EmployeeCreated v1 includes {id, name, manager}. v2 adds {costCenter}. Old subscribers reading v2 ignore costCenter; new subscribers handle both gracefully.

Governance: Central schema registry owned by IAM/Architecture team; governance board reviews schema changes quarterly.

7. Reconciliation and Healing

Detecting and Fixing Divergence

Despite atomicity efforts, state will diverge: network partitions, missed events, manual changes by administrators. Reconciliation detects and heals.

Hourly Reconciliation Loop: Query canonical model; query each system; compare. Alert if divergence. Auto-heal if safe (e.g., disable user missing in app system); escalate if risky (e.g., user present in only 3 of 50 apps).

Daily Deep Dive: Sample 1% of users; manually verify accounts in 5 random systems. If >1% divergence, trigger full resync.

8. Red Team Scenario: Message Ordering Exploit

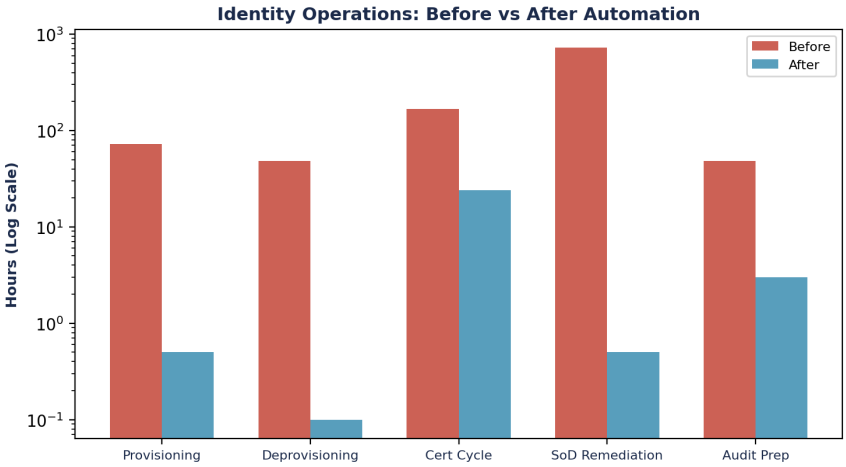

Figure 3: Market and Industry Analysis

9. Technology Stack for EIIP

Recommended Tools

Event Streaming: Apache Kafka, AWS Kinesis, or Azure Event Hubs. Kafka recommended for scale; native partition-by-key ordering.

Schema Registry: Confluent Schema Registry, AWS Glue, or custom JSON Schema validation.

Orchestration: Temporal, Apache Airflow, or cloud-native workflow services (AWS Step Functions, Azure Logic Apps).

Canonical Model (Data Lake): PostgreSQL, Snowflake, or cloud data warehouse storing canonical identity record with full audit trail.

Reconciliation Engine: Custom Python/Go service querying systems in parallel, comparing state, and triggering healing.

10. Implementation Roadmap

18-36 Month Journey

Phase 1 (Months 1-3): Document current data flows; identify top 3 integrations by volume and failure rate.

Phase 2 (Months 4-6): Deploy event streaming platform (Kafka or cloud pubsub); define canonical employee and user schemas.

Phase 3 (Months 7-12): Re-engineer top 3 integrations to event-driven. Implement orchestration layer. Build hourly reconciliation.

Phase 4 (Months 13-18): Migrate remaining integrations. Implement saga pattern for complex flows. Enable auto-healing.

Phase 5 (Months 19-24): Optimize for performance; implement real-time monitoring and alerting. Conduct resilience testing (chaos engineering).

Phase 6 (Months 25-36): Continuous refinement; evolve schemas; add new event types (approvals, exceptions).

11. Governance, Change Management, and Testing

Operating an Event-Driven System

Event-driven systems are more complex to operate than point-to-point integrations. Governance essentials:

Event Board: Quarterly meeting to review schema changes, resolve breaking changes, align on event taxonomy.

Testing Strategy: Unit tests for each handler; integration tests for multi-system flows; chaos engineering for failure scenarios.

Deployment: Blue-green deployment of orchestration logic; canary rollouts of new event handlers; easy rollback.

Monitoring: Alert on event lag (messages not processed within SLA); alert on schema validation failures; alert on reconciliation divergence >0.5%.

Executive Decision Dashboard

12. Data Privacy and Compliance in Event Streams

PII in Motion

Identity events contain PII (names, emails, SSN, addresses). Event streams must encrypt and protect.

Encryption in Transit: TLS/SSL for all event producers and consumers. Kafka brokers should use SSL encryption at rest and in transit.

Encryption at Rest: Kafka topics optionally encrypted at block storage layer; consider separate secrets topic for highly sensitive data (SSN, salary).

Data Retention: Event streams are append-only; implement topic retention policy (e.g., 90 days) to limit PII exposure window.

Access Control: Consumer applications must authenticate; RBAC restricts which teams can subscribe to which topics.

GDPR/CCPA compliance: Right to deletion requires tombstoning (logical deletion) rather than physical purge; reconciliation ignores tombstoned records.

13. Cloud-Native Considerations

AWS, Azure, GCP Event Services

Cloud providers offer managed event services: AWS EventBridge, Azure Event Hubs, GCP Pub/Sub.

Hybrid considerations: On-premise Kafka cluster with cloud bridge (AWS Kinesis Firehose) for reliable cross-boundary flow.

14. Conclusion

Enterprise identity governance is fundamentally an integration problem. Fragmented systems lead to data inconsistency, provisioning failures, and security gaps.

EIIP—event-driven architecture with canonical data model, saga transactions, and reconciliation loops—is the blueprint for scaling beyond 5-10 systems to 50-500.

The investment is significant: 18-36 months, multiple platforms (Kafka, orchestration, data warehouse), and cultural shift to event thinking. But the payoff is substantial: 10x faster onboarding, 99%+ consistency, and automated healing.

Organizations that master EIIP will achieve competitive advantage in security, compliance, and operational efficiency. Those that remain fragmented will face increasing regulatory pressure and security incidents.

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.

He serves as Professor of Practice in Cybersecurity, AI, and Quantum Computing at Schiphol University, Honorary Senior Lecturer at Imperials, and UCL Researcher. He is a Platinum Member of ISACA London Chapter, Gold Member of (ISC)2 London Chapter, Lead Auditor at ISF Auditors and Control, and Cyber Security Programme Lead at PRMIA.

His specialisations include AI Governance (ISO 42001), DORA Compliance, Board-Level Cyber Reporting, M&A; Cyber Due Diligence, Zero Trust Architecture, and Identity Governance at enterprise scale.

Contact: info@kieranupadrasta.com | www.kie.ie | linkedin.com/in/kieranupadrasta

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Core Takeaways	Board Questions	Key KPIs	90-Day Actions
Event-driven provisioning reduces onboarding latency from 7 days to <1 hour	How consistent is identity state across our systems? (Expected: >99.5% consistency)	Onboarding latency (target: <1 hour)	Map all identity integrations; identify top 3 by volume/failure
Saga pattern with compensating transactions enables atomic behavior without distributed locks	If a provisioning transaction fails mid-way, do we detect and fix it automatically?	State consistency across systems (target: >99.5%)	Design canonical employee and user schemas
Hourly reconciliation detects divergence within 60 minutes; enables rapid healing	Can we onboard a new hire in <2 hours with zero manual IT intervention?	Time to detect divergence (target: <1 hour)	Deploy event streaming platform (Kafka or cloud pubsub)

Core Takeaways	Board Questions	Key KPIs	90-Day Actions
		Automated healing rate (target: >90% of divergence auto-fixed)	

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

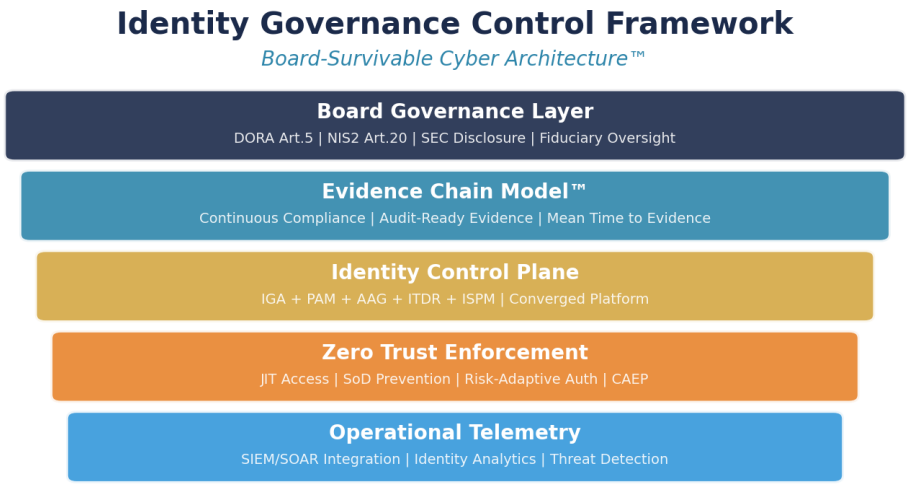

Figure 4: Board-Survivable Cyber Architecture™

Case Study: Global Payments Processor

ILLUSTRATIVE SCENARIO — Composited from multiple engagements. Details anonymised.

Organisation: Global Payments Processor (22,000 employees, 18 countries)

Challenge: 14 disconnected repos; no unified governance

Results: 14 repos unified; provisioning: hours to minutes

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

About the Author

Kieran Upadrasta

CISSP, CISM, CRISC, CCSP | MBA | BEng

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.

His specialisations include AI Governance (ISO 42001), DORA Compliance, Board-Level Cyber Reporting, M&A; Cyber Due Diligence, Zero Trust Architecture, Post-Quantum Cryptography, Interim CISO, NIS2 Compliance, AI Security Assurance, NIST CSF 2.0, and Operational Resilience.

Professional Memberships

- Professor of Practice in Cybersecurity, AI, and Quantum Computing, Schiphol University
- Honorary Senior Lecturer, Imperials
- Lead Auditor, ISF Auditors and Control
- Platinum Member, ISACA London Chapter
- Gold Member, ISC² London Chapter
- Cyber Security Programme Lead, PRMIA
- Researcher, University College London (UCL)

Contact: info@kieranupadrasta.com | www.kie.ie | linkedin.com/in/kieranupadrasta

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