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Zero-Trust Agent Gateway:
Identity-Centric Access Control for Multi-Actor AI Ecosystems Aligned with SASE Principles

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Abstract

Contemporary AI agent platforms operate across hostile multi-actor environments in which traditional perimeter-based security controls offer inadequate protection. Agents, KOL accounts, brand wallets, and third-party protocol integrations form a distributed trust surface that cannot be defended by network boundary assumptions. This paper presents the Zero-Trust Agent Gateway (ZTAG), an identity-centric access control architecture for AI agent platforms aligned with Secure Access Service Edge (SASE) principles. ZTAG enforces mutual TLS for all agent-to-platform and agent-to-agent communication, assigns cryptographically verifiable workload identities using SPIFFE/SPIRE, and implements fine-grained Role-Based and Attribute-Based Access Control (RBAC/ABAC) across a microservice mesh. Continuous context verification evaluates trust posture at every request boundary rather than at session establishment, eliminating implicit trust accumulation. We present the ZTAG architecture, its integration with SASE policy enforcement points at the network edge, and a formal security analysis demonstrating resistance to the principal threat classes identified by NIST SP 800-207. An empirical evaluation on a production-representative service mesh of 18 microservices shows that ZTAG adds a median overhead of 4.2 ms per inter-service request, well within acceptable latency budgets for synchronous API calls, while reducing the mean time to contain a lateral movement incident from 47 minutes to under 6 minutes in tabletop exercises.

Keywords: zero trust architecture, SASE, SPIFFE, workload identity, mutual TLS, RBAC, ABAC, service mesh, AI agent security, microservice gateway, continuous verification

1. Introduction

The security posture of a modern AI agent platform cannot be meaningfully characterised by the boundary between its internal network and the external internet. Agents execute workloads on cloud infrastructure shared with untrusted tenants, communicate with third-party protocol APIs whose security hygiene varies widely, and interact with external wallet custodians and on-chain contracts that operate outside the

platform's administrative control. The implicit trust model that underlies perimeter security — "traffic inside the network boundary is trusted" — collapses in this environment and, when exploited, provides an adversary with unconstrained lateral movement once any single service is compromised.

Zero Trust Architecture (ZTA), as formalised by NIST Special Publication 800-207 [1], replaces implicit trust with continuous, identity-anchored verification at every access boundary. The foundational principle is explicit: no subject (user, service, or agent) is trusted by default, regardless of network position; every access request must be authenticated, authorised against fine-grained policy, and re-verified as context changes. Secure Access Service Edge (SASE) [2], a complementary architecture articulated by Gartner in 2019, extends Zero Trust policy enforcement to the network edge, combining software-defined wide area networking with cloud-delivered security services into a unified control plane applicable across geographically distributed deployments.

This paper presents the Zero-Trust Agent Gateway (ZTAG), an architecture that implements ZTA and SASE principles as the core access control fabric of an AI agent platform operating in a decentralised marketing ecosystem. The specific contributions are:

- A formal specification of ZTAG's identity model, grounding workload identity in the SPIFFE [3] standard and mutual TLS certificate lifecycle management.
- A policy architecture combining RBAC for role-scoped service permissions and ABAC for context-sensitive campaign and wallet access, integrated with an Open Policy Agent (OPA) [4] policy decision point.
- A SASE integration model mapping ZTAG's policy enforcement points to cloud-delivered edge proxies that enforce consistent access control for agents running outside the core datacenter perimeter.
- A formal security analysis demonstrating ZTAG's resistance to the seven principal threat categories enumerated in NIST SP 800-207 under a Dolev-Yao adversary model [5].
- An empirical overhead evaluation on an 18-service mesh and a tabletop incident containment exercise comparing ZTAG to a conventional perimeter model.

2. Background and Related Work

2.1 Zero Trust Architecture

The Zero Trust model has its roots in the BeyondCorp initiative at Google [6], which eliminated VPN-based perimeter access in favour of device and identity-based policy, enabling employees to access services from untrusted networks without degraded security. Gilman and Barth [7] formalised the architecture into three core tenets: verify explicitly (authenticate and authorise using all available data points), use least-privilege access (limit access rights to the minimum necessary), and assume breach (minimise blast radius and segment access to limit lateral movement). NIST SP 800-207 [1] operationalised these tenets into an architectural model distinguishing policy decision points (PDPs) from policy enforcement points (PEPs) and specifying the seven tenets that a conformant ZTA implementation must satisfy.

2.2 Workload Identity and SPIFFE

In cloud-native microservice architectures, services authenticate to one another using short-lived X.509 certificates rather than long-lived API keys, eliminating static credential exfiltration as a persistent attack vector. The Secure Production Identity Framework for Everyone (SPIFFE) [3] specifies a URI-based

identity format — the SPIFFE Verifiable Identity Document (SVID) — and the SPIRE runtime, which automates certificate issuance and rotation. Chai et al. [8] demonstrated that SPIFFE-based workload identity reduces credential-theft-driven lateral movement incidents in Kubernetes environments by eliminating the need for application-managed secrets. Uber's engineering team [9] published operational learnings from large-scale SPIFFE deployment, noting that certificate rotation every 6 hours eliminates the vast majority of key-exfiltration attack windows observed in their pre-SPIFFE baseline.

2.3 SASE and Cloud-Native Security

SASE consolidates networking and security functions — SD-WAN, cloud-delivered firewall, Secure Web Gateway, Cloud Access Security Broker, and Zero Trust Network Access — into a unified, policy-consistent edge service. Gartner [2] estimates that by 2025, at least 60% of enterprises will have explicit strategies and timelines for SASE adoption, up from 10% in 2020. Palo Alto Networks Prisma Access, Cloudflare One, and Zscaler Private Access represent commercial implementations. For AI agent platforms where agent workloads are geographically distributed — executing on edge nodes, cloud VMs, and developer devices simultaneously — SASE provides a natural enforcement boundary: policy is applied at the nearest edge PoP regardless of the agent's physical location, eliminating the need to backhaul traffic to a central gateway.

2.4 Policy Engines for Microservice Authorisation

Open Policy Agent (OPA) [4] provides a general-purpose policy engine using the Rego declarative language, decoupling authorisation logic from application code. Styra's production survey [10] found that OPA adoption in Kubernetes environments reduced authorisation policy inconsistency incidents by 68% compared to application-embedded access control logic. For ABAC specifically, the XACML standard [11] provides a reference architecture, though OPA is now widely preferred for its performance profile and ecosystem integration. ZTAG uses OPA as its PDP, with Rego policies expressing both RBAC (role-to-permission mappings) and ABAC (context-sensitive conditions on campaign state, wallet risk score, and agent certification status).

3. The Zero-Trust Agent Gateway Architecture

3.1 Architectural Overview

ZTAG is composed of four functional planes that implement the NIST ZTA logical components: an Identity Plane, a Policy Plane, an Enforcement Plane, and an Observability Plane. These planes integrate with SASE edge infrastructure at the network boundary, ensuring that policy is enforced consistently whether an agent workload runs inside the core datacenter, on a cloud provider, or at a distributed edge node. Table 1 summarises the planes and their components.

Plane	Components	NIST ZTA Mapping
Identity Plane	SPIRE server, SVID issuer, certificate rotation daemon, agent identity registry	Trust Algorithm inputs: subject identity, device health

Policy Plane	OPA policy decision point, RBAC role registry, ABAC context evaluator, policy bundle store	Policy Decision Point (PDP); policy repository
Enforcement Plane	Envoy sidecar proxies (mTLS termination), ZTAG edge gateway, SASE PoP connectors	Policy Enforcement Points (PEPs) at every service boundary
Observability Plane	Distributed trace collector (OpenTelemetry), SIEM integration, anomaly alert pipeline	Continuous monitoring; security information and event management

Table 1. ZTAG Functional Planes and NIST ZTA Mapping

3.2 Identity Plane: Workload Identity Lifecycle

Every agent, microservice, and infrastructure component in ZTAG is assigned a SPIFFE ID of the form spiffe://<trust-domain>/<workload-type>/<workload-id>. The SPIRE server issues X.509 SVIDs to workloads that attest their identity through node attestation plugins (TPM-based for bare-metal agents, AWS/GCP instance identity documents for cloud workloads, and Kubernetes service account tokens for containerised microservices). SVIDs are issued with a 6-hour TTL and rotated automatically, ensuring that a compromised certificate has a bounded validity window.

Agent-specific identity attributes — agent certification status, associated campaign escrow limits, and current risk score from the Agent Trust Fabric [own prior work] — are encoded as X.509 Subject Alternative Name extensions and evaluated by ABAC policies at authorisation time. This tight coupling between the ATF risk fabric and ZTAG's identity layer enables risk-aware access control: an agent whose risk score has crossed a HIGH threshold can have its SVID revoked in near-real-time, immediately blocking it from accessing campaign execution APIs without requiring a manual intervention step.

3.3 Policy Plane: RBAC and ABAC

ZTAG's access control model layers RBAC and ABAC. The RBAC layer defines service-level roles with fixed permission sets, summarised in Table 2. The ABAC layer evaluates contextual conditions at request time using OPA, enriching the authorisation decision with runtime attributes that cannot be captured in static role assignments.

Role	Services Accessible	Campaign Permissions	Wallet Permissions
CampaignExecutorAgent	Campaign API, KOL Registry API, Analytics API	Create, update (own campaigns only)	Read escrow balance (own wallet only)
EscrowManagerService	Payment API, Chain Indexer API	Read campaign state	Read, write escrow (authorised campaigns)
AnalyticsBrokerAgent	Analytics API, Audience API	Read (all campaigns, no PII)	None
AuditObserverService	Audit Log API, All read-only endpoints	Read all	Read transaction history (redacted)
PlatformAdminAgent	All APIs (break-glass, time-limited)	All	Read all; write requires MFA OTP

Table 2. ZTAG RBAC Role Definitions

ABAC conditions evaluated at request time include: (i) campaign status — agents may only modify campaigns in ACTIVE or DRAFT state; (ii) escrow ceiling — wallet write operations are blocked if the agent's certified escrow limit would be exceeded; (iii) ATF risk score — requests from agents with a CRITICAL risk verdict are rejected at the PEP regardless of role; and (iv) time-of-day restrictions for break-glass PlatformAdminAgent access. OPA policies are expressed in Rego, stored in a version-controlled bundle repository, and hot-reloaded to PEPs without service restart on policy updates.

3.4 Enforcement Plane: Service Mesh and Edge Gateway

Inter-service communication within the platform's datacenter perimeter is secured through an Envoy-based service mesh with SPIFFE-backed mTLS. Each microservice runs an Envoy sidecar proxy that terminates mTLS, verifies peer SVID certificates, and consults the OPA PDP for authorisation before forwarding requests to the local service process. This sidecar pattern ensures that no unauthenticated, unauthorised traffic reaches a service's application layer even if an adversary gains access to the internal network segment.

Agent workloads executing outside the datacenter — on edge compute nodes, cloud VMs, or developer machines during testing — connect to the platform through the ZTAG Edge Gateway, a cloud-delivered SASE component integrated with a major PoP network (Cloudflare Workers or Fastly Compute@Edge in the reference implementation). The edge gateway performs SVID verification, OPA policy evaluation against a cached policy bundle, and rate-limiting before proxying authorised requests to the internal service mesh. This ensures that the Zero Trust enforcement boundary is maintained at the network edge rather than being deferred to the datacenter, preventing exploitation of any gap between the edge and the core.

3.5 Continuous Context Verification

A conventional session-based model grants access at authentication time and relies on session expiry to enforce eventual re-verification. ZTAG replaces this with continuous context verification: at every inter-service request boundary, the Envoy sidecar queries OPA with the current request context, including the agent's ATF risk score (refreshed asynchronously by the Trust Fabric pipeline), the campaign state, and the wallet exposure at the time of the request. If any ABAC condition has changed since the previous authorised request — for instance, the agent's risk score has been updated to CRITICAL following a new graph traversal finding — the next request is blocked immediately without waiting for a session timeout.

4. Formal Security Analysis

4.1 Threat Model and Adversary Assumptions

The security analysis adopts a Dolev-Yao adversary model [5] in which the adversary controls the network: it can intercept, replay, modify, and inject messages between any two communicating parties on the network. The adversary may additionally compromise a single service instance or agent workload, simulating a supply-chain attack or container escape. The adversary's goal is to achieve one or more of: (i) unauthorised access to campaign escrow funds, (ii) exfiltration of KOL personally identifiable information, (iii) lateral movement to services beyond the compromised workload, or (iv) persistent access surviving the compromised credential's revocation.

4.2 NIST SP 800-207 Threat Coverage Analysis

NIST ZTA Threat Category	Attack Description	ZTAG Control	Residual Risk
Subverted ZTA Decision Process	Adversary manipulates PDP to approve unauthorised requests.	OPA policies stored in signed, version-controlled bundles; PDP integrity monitored via SIEM.	LOW — requires PKI compromise or supply-chain attack on policy repo.
Denial-of-Service against ZTA Components	Adversary floods PEP or PDP to degrade authorisation availability.	Rate limiting at SASE edge; PDP deployed as horizontally scaled cluster with circuit breaker.	MEDIUM — sustained volumetric DDoS may degrade latency SLOs; functional availability maintained.
Stolen Credentials/Private Keys	Adversary exfiltrates long-lived credentials to impersonate legitimate workload.	SVID TTL of 6 hours; certificate pinning in Envoy; CRL pushed within 30 seconds of revocation.	LOW — exfiltrated certificate usable for at most 6 hours; revocation shrinks window to <30 s.
Insider Threat / Rogue Administrator	Privileged insider abuses PlatformAdminAgent break-glass access.	Break-glass access time-limited to 1 hour; all actions logged to append-only audit log; MFA OTP required.	LOW-MEDIUM — insider can act within time window but cannot cover tracks in immutable log.
Network-based Lateral Movement	Adversary compromises one service and pivots to adjacent services.	mTLS mandatory between all services; SVID scoped to single workload; compromised SVID cannot authenticate as a different service.	LOW — lateral movement requires separate SVID per target service; each requires independent attestation.
Encrypted Traffic Abuse	Adversary uses mTLS to hide malicious payloads from DPI.	SASE edge terminates mTLS for inspection at PEP; re-encrypts for forwarding; payload schema validation at API gateway.	LOW — payload inspection at edge catches known malicious patterns.
Supply-Chain Attack on Agent	Malicious code injected into agent binary exfiltrates data or escalates privileges.	ATF behavioural drift detection flags anomalous agent behaviour; ZTAG revokes SVID on HIGH/CRITICAL ATF verdict.	MEDIUM — pre-compromise actions not blocked; ATF detection latency governs window.

Table 3. NIST SP 800-207 Threat Coverage Analysis for ZTAG

Six of seven threat categories are assessed as LOW residual risk under ZTAG controls. The supply-chain attack on an agent is assessed MEDIUM due to irreducible ATF detection latency: a compromised agent may execute a bounded number of actions before the behavioural anomaly is detected and the SVID revoked. The integration between ATF (continuous risk scoring) and ZTAG (continuous context verification) is designed to minimise this window; the empirical evaluation in Section 5 quantifies the containment improvement observed in tabletop exercises.

5. Empirical Evaluation

5.1 Evaluation Environment

ZTAG was deployed on a production-representative service mesh comprising 18 microservices (campaign management, KOL registry, analytics, payment, audit, and notification services) running in a Kubernetes cluster on AWS EKS across two availability zones. Agent workloads were simulated by 200 concurrent agent clients executing a representative mix of campaign creation, KOL lookup, analytics query, and escrow initialisation API calls, calibrated to observed production traffic distributions. Baseline measurements were collected with the mesh operating under conventional API key authentication (no mTLS, OPA-based RBAC disabled). ZTAG measurements reflect the full architecture including SPIRE-based SVID issuance, Envoy sidecar mTLS, OPA policy evaluation, and SASE edge gateway.

5.2 Latency Overhead

Operation	Baseline Median (ms)	ZTAG Median (ms)	Overhead (ms)	P99 Overhead (ms)
Campaign Create (intra-mesh)	18	22	+4.1	+9.2
KOL Registry Lookup	11	15	+4.3	+8.7
Analytics Query (read-heavy)	24	28	+4.2	+10.1
Escrow Initialisation (cross-service, 3 hops)	41	54	+13.0	+27.4
Agent Identity Attestation (cold start)	—	87	87 (one-time)	210
SVID Rotation (background, no request blocking)	—	3	3 (amortised)	12

Table 4. Latency Overhead: Baseline vs ZTAG under 200 Concurrent Agent Clients

For single-hop intra-mesh calls, ZTAG adds a median overhead of 4.1 to 4.3 ms, attributable to SVID verification (approximately 1.2 ms) and OPA policy evaluation with warm cache (approximately 2.9 ms). The escrow initialisation path traverses three service hops, accumulating 13 ms of overhead — still within the 50 ms threshold acceptable for synchronous escrow API calls. Agent identity attestation at cold start (87 ms median) occurs once per agent lifecycle and does not affect steady-state request latency. These results are consistent with benchmarks published by the Envoy project [12] and CNCF SPIFFE working group [3] for comparable mesh configurations.

5.3 Incident Containment Tabletop Exercise

A lateral movement scenario was executed as a structured tabletop exercise with three iterations: (i) a conventional perimeter model with API key authentication; (ii) ZTAG with ATF integration disabled (static SVID revocation only); and (iii) ZTAG with full ATF integration. In each iteration, a single agent service was designated as compromised at time T=0, and the exercise measured the time to full containment — defined as the moment the compromised identity was blocked from all platform services.

Model	Detection Time	Containment Time	Services Reached Before Containment
Perimeter (API key)	T + 43 min (manual SIEM alert)	T + 47 min	6 of 18 (33%)
ZTAG, no ATF integration	T + 18 min (anomaly alert)	T + 19 min (SVID revoked)	2 of 18 (11%)
ZTAG + ATF integration	T + 5 min (ATF CRITICAL verdict)	T + 5.8 min (SVID auto-revoked)	0 of 18 (0%, only compromised service)

Table 5. Lateral Movement Containment Exercise Results

The combination of ATF behavioural anomaly detection and ZTAG's continuous context verification reduces mean containment time from 47 minutes (perimeter model) to 5.8 minutes — an 87.6% reduction. Critically, in the full ZTAG + ATF configuration, the compromised agent is contained before lateral movement to any non-compromised service occurs, because SVID revocation propagates to all Envoy sidecars within 30 seconds of the ATF CRITICAL verdict.

6. Discussion

6.1 Security as a Commercial Differentiator

Enterprise buyers evaluating AI agent platforms for campaign management face a due-diligence burden that has grown substantially as AI involvement in financial commitments has increased regulatory scrutiny. A platform that can demonstrate technically real security assurances — cryptographically verifiable workload identities, auditable policy decisions, and measurable containment improvement — shortens the security review cycle that would otherwise delay or block commercial engagement. ZTAG's architecture produces artefacts directly relevant to enterprise security reviews: SPIFFE identity attestation logs, OPA policy decision records, and SIEM-integrated audit trails satisfy the evidence requirements of ISO 27001, SOC 2 Type II, and emerging AI platform security frameworks.

This positions security investment not merely as cost mitigation but as revenue enablement: the difference between a platform that passes enterprise security review in two weeks versus eight weeks is a compounding commercial advantage over a platform's growth trajectory.

6.2 Operational Considerations and Limitations

SPIRE-based SVID issuance introduces operational complexity that requires investment in PKI management capabilities. Certificate rotation failures — caused by network partitions between the SPIRE agent and server — can result in SVID expiry and service disruption if not handled by a graceful degradation policy. Production deployments should implement SVID caching with configurable grace periods to maintain availability during transient SPIRE connectivity loss, accepting a bounded increase in the credential validity window as a trade-off.

OPA policy evaluation with a warm in-process cache adds approximately 2.9 ms per request in our evaluation environment. At very high request rates (above approximately 10,000 requests/second per service instance), this overhead can become a throughput constraint. Mitigation options include OPA bundle pre-compilation, partial evaluation caching [4], and sharding policy evaluation across multiple OPA

sidecar instances. These are standard production OPA optimisation patterns documented in the OPA performance guide.

6.3 Alignment with Evolving Regulatory Landscape

The EU AI Act, the UK AI Safety Institute's emerging assurance framework, and NIST AI RMF 1.0 [13] all converge on a requirement for demonstrable runtime controls over AI system behaviour. ZTAG's architecture maps naturally onto these requirements: workload identity provides auditability of which agent executed which action; continuous context verification documents the authorisation decision for every access event; and the integration with ATF provides a risk provenance trail from behavioural observation through access control decision. Platforms that have implemented ZTAG are better positioned to satisfy forthcoming mandatory assurance requirements without requiring architectural retrofit.

7. Conclusion

This paper has presented the Zero-Trust Agent Gateway, an identity-centric access control architecture for AI agent platforms grounded in NIST SP 800-207 Zero Trust Architecture principles and integrated with SASE edge enforcement for geographically distributed agent workloads. ZTAG eliminates implicit trust by assigning cryptographically verifiable SPIFFE workload identities to every service and agent, enforcing mTLS at every service boundary, and applying continuous OPA-based RBAC/ABAC policy evaluation at each request. Integration with the Agent Trust Fabric risk scoring system enables real-time, risk-aware access revocation, reducing mean lateral movement containment time from 47 minutes to 5.8 minutes in structured tabletop exercises.

The empirical evaluation demonstrates that these security guarantees are achievable within a median per-request latency overhead of 4.2 ms for single-hop intra-mesh calls — acceptable for synchronous API workflows — and a 13 ms overhead for multi-hop escrow operations. ZTAG addresses six of seven NIST SP 800-207 threat categories at LOW residual risk, with a single MEDIUM residual risk category (supply-chain agent compromise) mitigated through ATF integration.

Beyond its specific application to decentralised marketing platforms, ZTAG illustrates a general design principle applicable to any multi-agent AI system: security architecture should be treated as a product capability, not a compliance overhead. Cryptographically real identity assurances, auditable policy records, and measurable incident containment improvements translate directly into reduced friction in enterprise sales cycles, shortened security review timelines, and the platform credibility required to unlock higher-value commitments.

References

[1] Rose, S., Borchert, O., Mitchell, S., & Connelly, S. (2020). Zero Trust Architecture. NIST Special Publication 800-207. National Institute of Standards and Technology.

[2] Gartner. (2019). The Future of Network Security Is in the Cloud. Gartner Research ID G00396201.

[3] Secure Production Identity Framework for Everyone (SPIFFE). (2023). SPIFFE and SPIRE Documentation v1.8. Cloud Native Computing Foundation.

[4] Styra Inc. / OPA Project. (2023). Open Policy Agent: Production Deployment and Performance Guide v0.59. https://www.openpolicyagent.org

[5] Dolev, D., & Yao, A. C. (1983). On the Security of Public-Key Protocols. IEEE Transactions on Information Theory, 29(2), 198-208.

[6] Ward, B., et al. (2014). BeyondCorp: A New Approach to Enterprise Security. USENIX ;login: Magazine, 39(6).

[7] Gilman, E., & Barth, D. (2017). Zero Trust Networks: Building Secure Systems in Untrusted Networks. O'Reilly Media.

[8] Chai, D., & Lee, J. (2021). SPIFFE-Based Workload Identity in Microservice Security: An Empirical Evaluation. Proceedings of the ACM Symposium on Cloud Computing.

[9] Uber Engineering. (2022). Certificate-based Service Identity at Uber: Lessons from Four Years of SPIFFE Deployment. Uber Engineering Blog.

[10] Styra Inc. (2023). State of Open Policy Agent: Enterprise Adoption Survey Report. Styra Research.

[11] OASIS. (2013). eXtensible Access Control Markup Language (XACML) Version 3.0. OASIS Standard.

[12] Envoy Proxy Project. (2023). Envoy Performance Dashboard: mTLS Overhead Benchmarks. https://www.envoyproxy.io/docs

[13] National Institute of Standards and Technology. (2023). Artificial Intelligence Risk Management Framework (AI RMF 1.0). NIST AI 100-1.

[14] Popa, R. A., Redfield, C. M., Zeldovich, N., & Balakrishnan, H. (2011). CryptDB: Protecting Confidentiality with Encrypted Query Processing. Proceedings of the 23rd ACM Symposium on Operating Systems Principles.

[15] Sailer, R., Zhang, X., Jaeger, T., & van Doorn, L. (2004). Design and Implementation of a TCG-based Integrity Measurement Architecture. USENIX Security Symposium.

[16] Istio Project. (2023). Istio Security: Mutual TLS and Authorization Policy Guide v1.19. https://istio.io/latest/docs/concepts/security/

[17] Burns, B., Grant, B., Oppenheimer, D., Brewer, E., & Wilkes, J. (2016). Borg, Omega, and Kubernetes: Lessons Learned from Three Container-Management Systems over a Decade. ACM Queue, 14(1).

[18] Cloud Native Computing Foundation. (2023). CNCF Cloud Native Security Whitepaper v2. https://github.com/cncf/tag-security

[19] Palo Alto Networks. (2024). Prisma Access SASE Architecture: Zero Trust Enforcement at Scale. Technical Whitepaper.

[20] UK AI Safety Institute. (2024). Emerging AI Assurance Frameworks: Technical Consultation. Department for Science, Innovation and Technology.