# Securing Agentic AI Enterprise Workflows Against Prompt Injection Tool Poisoning Memory Manipulation and Excessive Agency Threats

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***Abstract***
*Agentic artificial intelligence systems extend language models with planning, memory, tool invocation, data access, and autonomous action, creating enterprise capabilities that also expand the security boundary beyond prompt-response applications. This review examines how prompt injection, tool poisoning, memory manipulation, and excessive agency threaten agentic workflows across finance, healthcare, software development, customer operations, and critical business services. It analyzes direct and indirect prompt injection through user inputs, retrieved documents, webpages, emails, databases, and multimodal content, emphasizing how untrusted instructions can override policy or redirect plans. Tool poisoning is examined through malicious descriptions, compromised connectors, deceptive outputs, dependency tampering, and excessive permissions that enable unauthorized data access or transactions. The review further evaluates memory attacks through false fact insertion, persistence abuse, cross-session contamination, sensitive-data retention, and retrieval manipulation. Excessive agency is framed as a control failure arising when agents possess broad objectives, inadequate constraints, irreversible tools, or weak human oversight. Defensive approaches include instruction-data separation, contextual trust labeling, least-privilege authorization, capability-based tool access, schema validation, content sanitization, provenance tracking, memory partitioning, transactional safeguards, runtime policy enforcement, and human approval for consequential actions. Detection methods combining behavioral telemetry, execution graphs, anomaly scoring, canary resources, and policy-violation monitoring are compared using attack success rate, false alarms, intervention latency, task utility, and operational cost. The paper proposes a defense-in-depth framework spanning design-time threat modeling, pre-execution validation, constrained planning, monitored tool use, post-action verification, and recoverable state management. Key challenges include adaptive adversaries, ambiguous instruction hierarchies, third-party integrations, long-horizon attacks, evaluation realism, and the trade-off between autonomy and control. The review argues that secure enterprise deployment requires treating agentic artificial intelligence as a privileged software actor whose intentions, capabilities, memory, actions, and consequences must remain authenticated, bounded,*

*observable, and reversible. This perspective provides a basis for governance, assurance, incident response, and standardized evaluation of autonomous enterprise workflows.*

***Keywords:*** *Agentic artificial intelligence; enterprise workflow security; excessive agency; memory manipulation; prompt injection; tool poisoning*

## 1. Introduction

### 1.1 Background and Evolution of Agentic AI Enterprise Workflows

Agentic artificial intelligence extends the conventional language-model interface by allowing a system to interpret objectives, decompose tasks, formulate plans, invoke tools, observe results, update working state, and continue acting with limited supervision. Enterprise agents may search knowledge bases, summarize communications, create software changes, update customer records, schedule activities, initiate procurement, or generate analytical reports. Their architectures commonly combine a foundation model with an orchestrator, planning loop, tool registry, retrieval layer, short-term context, persistent memory, identity services, and execution environment. This composition changes the model from an advisory component into a software actor operating across application programming interfaces and organizational boundaries. API-governance principles are consequently relevant because every connector introduces dependencies, permissions, schemas, and failure modes that require continuous oversight (Aliliele et al., 2023b). Integrated operations architectures further illustrate the importance of unified visibility across interconnected services (Ladapo et al., 2024). These capabilities support workflows previously requiring human judgment and execution. The evolution toward agents has progressed from single-turn generation to retrieval-augmented assistants, function-calling systems, workflow copilots, and autonomous multi-agent arrangements. Early assistants returned text for human execution; contemporary agents can choose actions, call multiple services, retain cross-session information, and delegate subtasks. This progression improves productivity but creates compound risk because one manipulated observation can influence later planning, memory, and tool selection. Enterprise deployment also introduces heterogeneous trust levels: user prompts, internal documents, webpages, emails, databases, and tool responses may all enter the same context despite differing authority. Security-operations architectures demonstrate why behavioral telemetry and automated response must be coordinated across such environments (Adegbite et al., 2024b). Algorithmic accountability likewise requires organizations to document how automated decisions are produced and governed (Annan, 2024). Agentic AI should therefore be understood as a distributed workflow system whose model reasoning, data ingestion, authorization, memory, external actions, and recovery mechanisms form one security-relevant execution chain.

### 1.2 Security Motivation and Limitations of Conventional AI Defenses

The security motivation arises from the mismatch between an agent's broad capabilities and the uncertain trustworthiness of its instructions and observations. Prompt injection can cause retrieved text, emails, webpages, or documents to override intended policy. Tool poisoning can manipulate descriptions, schemas, dependencies, or outputs so the agent selects a malicious function or misinterprets results. Memory attacks can insert false facts, persist hostile instructions, expose sensitive information, or contaminate future sessions. Excessive agency occurs when an agent receives objectives and permissions that allow irreversible actions without adequate approval or consequence checking. Vulnerability governance demonstrates the need to map exposures, assign ownership, and verify remediation rather than relying on isolated filters (Adegbite et al., 2024a).

Privacy-by-design is equally necessary because agent contexts may combine personal information from multiple enterprise services (Badmus et al., 2024).

Conventional AI defences are limited because they concentrate on harmful model outputs, jailbreak prompts, or static content moderation at a single interface. They often assume that retrieved material is data rather than executable instruction, tools are trustworthy, memory is passive, and the user remains the final actor. These assumptions fail when an agent autonomously reads untrusted content, composes multistep plans, and invokes privileged services. Input filtering cannot reliably infer every hidden instruction, while output moderation may occur after a harmful transaction has already executed. Static allowlists also provide insufficient protection when permitted tools accept dangerous parameters or return poisoned content. Continuous breach simulation can test whether controls remain effective against changing attack paths (Dosunmu & Ogundele, 2024a). Identity-centric zero-trust principles require authorization to be evaluated for every user, agent, tool, resource, and action rather than inherited from a trusted session (Ogbole et al., 2021). Effective defence must therefore constrain capabilities, separate instructions from data, validate plans and parameters, monitor execution, require approval for consequential actions, and support rollback continuously.

### 1.3 Scope, Objectives, Research Questions, and Review Organization

This review examines security threats affecting enterprise agentic artificial intelligence workflows that combine language models with planning, tools, retrieval, memory, and autonomous execution. Its scope covers direct, indirect, multimodal, and persistent prompt injection; malicious tool descriptions, compromised connectors, deceptive outputs, dependency tampering, and excessive permissions; memory poisoning, cross-session contamination, retrieval manipulation, and sensitive-data persistence; and excessive agency arising from broad goals, weak constraints, or irreversible actions. The analysis includes design-time threat modeling, runtime authorization, sandboxing, policy enforcement, human approval, monitoring, incident response, and recoverable state management. General model misinformation is considered only where it influences tool use, memory, authorization, or enterprise workflow consequences. The review emphasizes enterprise deployments in which agent actions can directly alter data, software, finances, communications, access rights, or legally significant organizational records.

The review aims to synthesize fragmented threats and controls into a defense-in-depth framework for secure enterprise deployment. Four questions guide the study. First, how do untrusted instructions propagate through planning, retrieval, memory, and tool-execution loops? Second, which technical controls prevent poisoned tools or memory from influencing consequential actions? Third, how should organizations balance useful autonomy with least privilege, human oversight, reversibility, and operational efficiency? Fourth, which benchmarks and metrics measure attack resistance without ignoring task utility and intervention cost? Section 2 defines agent components, trust boundaries, integrations, adversaries, and attack chains. Section 3 analyzes prompt injection and tool poisoning. Section 4 addresses memory manipulation and excessive agency. Section 5 evaluates runtime defences, benchmarks, case studies, and implementation guidance. Section 6 examines governance, incident response, standardization, reproducibility, research opportunities, and implications for secure agentic systems.

## 2. Agentic AI Architectures and Enterprise Threat Landscape

### 2.1 Agent Components, Planning Loops, Tools, Memory, and Execution Environments

An enterprise agent typically combines a foundation model, system instructions, an orchestration layer, planning logic, tool interfaces, retrieval services, memory stores, identity credentials, and an execution environment. The model interprets the objective and proposes actions, while the orchestrator manages state, tool calls, retries, and stopping conditions. Planning may be explicit, producing task graphs or ordered steps, or implicit within repeated model interactions. Each observation is appended to the working context and can alter subsequent decisions. Tool registries expose names, descriptions, schemas, permissions, and endpoints, making their metadata security-critical. Data-classification frameworks can assign sensitivity and handling requirements to observations and tool outputs (Aliliele et al., 2024a). Agile digital-transformation controls support traceable changes across integrated components (Mbonu et al., 2020a), while infrastructure-as-code governance makes execution environments and permissions reproducible (Mbonu et al., 2020b). Distributed sensor architectures illustrate how diverse observations can influence automated decisions (Kumuyi et al., 2024a). For example, a procurement agent may decompose a purchase request into vendor discovery, compliance screening, quotation comparison, approval, and order creation. Every transition should retain the initiating objective, supporting evidence, and permitted action envelope. Memory may include the immediate context window, episodic interaction history, semantic facts, user preferences, procedural knowledge, and retrieved organizational documents. Persistent memory increases continuity but also extends the lifetime of false or malicious information. Memory systems should record source, timestamp, confidence, scope, sensitivity, and expiration while separating user-specific, task-specific, and global knowledge. Execution environments range from restricted sandboxes to privileged enterprise services capable of modifying files, databases, software, communications, or financial records. Plans should therefore be checked against authorization, budget, data-classification, and reversibility constraints before execution. Service-management platforms illustrate the complexity of coordinating workflows, identities, and records (Ladapo et al., 2023a). Systems-engineering frameworks emphasize dependencies between digital services and operational processes (Okonkwo et al., 2023). Capacity planning helps bound concurrent agents, context growth, and resource consumption (Edivri & Oteri, 2022), while scalable gateway architectures demonstrate controlled movement between services and trust domains (Akomolafe et al., 2024a). Container isolation, read-only mounts, network-egress policies, ephemeral credentials, deterministic timeouts, and transaction-level idempotency limit damage when reasoning fails. Human approval remains necessary for high-impact, ambiguous, or difficult-to-reverse operations.

### 2.2 Trust Boundaries, Attack Surfaces, and Enterprise Integration Risks

Trust boundaries arise wherever instructions, data, identities, or capabilities cross between users, agents, models, tools, memory stores, and external systems. Enterprise workflows may combine authoritative system policies with untrusted emails, webpages, uploaded files, retrieved documents, database content, and tool responses inside one context. If provenance and authority are not preserved, the model may interpret hostile data as an instruction. Authentication proves identity but does not establish whether a requested action is appropriate for the current objective. Authorization should therefore evaluate the user, agent, tool, resource, parameters, purpose, and transaction consequence at execution time. Privacy-preserving governance demonstrates the need to protect data as they move across platforms (Afrihyia et al., 2024). Compliant analytics architectures connect information sensitivity to enforceable technical controls (Aliliele et al.,

2024b), access-control studies expose risks associated with distributed devices (Ladapo et al., 2023b), and cloud identity-governance frameworks show why privileges must be continuously reviewed (Mbonu et al., 2022b). Strong designs label every context segment by origin and permitted influence, isolate retrieved content from control instructions, and require capability-scoped tokens. Policy enforcement outside the language model prevents persuasive text from redefining authority. The attack surface includes prompts, retrieval indexes, embeddings, tool descriptions, function schemas, connectors, dependencies, logs, memory-write paths, approval interfaces, and orchestration software. Enterprise integration increases risk when agents inherit broad service accounts, reuse tokens across tools, access production data, or invoke third-party connectors with opaque security properties. A compromised tool can return deceptive content, while a legitimate tool can become dangerous through malicious parameters. Multi-agent systems add delegation risks because one agent may trust another agent's outputs without knowing their sources or associated permissions. Monitoring should correlate plans, tool calls, identity events, memory changes, data movement, and resulting transactions. Threat-intelligence integration supports cross-system detection (Dosunmu & Ogundele, 2022), preventive-control models emphasize separation of duties (Dogbatsey et al., 2020), privacy-centric engineering helps protect sensitive interfaces (Okoruwa et al., 2020), and resilience frameworks demonstrate why critical integrations require fallback and recovery arrangements (Ogunwole et al., 2021) as seen in Table 1. Integration testing should inject poisoned documents, malformed tool results, stale credentials, conflicting instructions, and unavailable dependencies. Controls should fail closed, preserve audit evidence, and allow operators to suspend execution without losing recoverable workflow state.

**Table 1: Trust Boundaries and Enterprise Agent Security Risks**

| Security Area | Primary Risk | Typical Exposure | Recommended Controls |
|---|---|---|---|
| Trust boundaries | Untrusted data interpreted as authoritative instructions | Emails, webpages, documents, databases, memory, and tool responses | Label provenance and authority, separate instructions from data, and enforce policies outside the model |
| Identity and authorization | Valid identities performing inappropriate actions | Broad service accounts, reused tokens, excessive privileges, and unauthorized parameters | Apply least privilege, capability-scoped tokens, contextual authorization, and continuous privilege review |
| Agentic attack surface | Manipulation of agent planning or execution | Prompts, retrieval indexes, embeddings, tool schemas, connectors, logs, and memory-write paths | Validate inputs and outputs, secure dependencies, restrict memory writes, and monitor tool-call sequences |
| Enterprise integration | Compromise propagating across connected systems | Production databases, third-party connectors, multi-agent delegation, and administrative services | Segment integrations, verify delegated outputs, separate duties, correlate telemetry, test failures, and maintain recoverable state |

### 2.3 Adversary Models, Threat Taxonomies, and Agentic Attack Chains

An adversary model should specify objectives, knowledge, access, capabilities, persistence, resources, and tolerance for detection. External attackers may inject instructions through public

content or compromised connectors; malicious users may craft direct prompts; insiders may poison memory or misuse approvals; and suppliers may alter tools, dependencies, or data feeds. Objectives include data exfiltration, unauthorized transactions, code execution, credential theft, policy bypass, persistence, misinformation, and service disruption. Attackers may possess only black-box access or detailed knowledge of prompts, tools, memory schemas, and authorization logic. Risk-scoring methods can prioritize adversaries by likelihood and consequence (Akomolafe et al., 2023). Cyber-risk quantification supports comparison of control investments (Dosunmu & Ogundele, 2024b), anomaly models help identify deviations across sequential activity (Atakpa & Fobellah, 2023), and portfolio-risk frameworks illustrate the aggregation of interacting exposures (Eboh & Aliliele, 2023). Assessment must distinguish opportunistic attackers from well-resourced actors able to maintain poisoned knowledge sources, compromise vendor infrastructure, or coordinate social engineering with technical exploitation. Assumed defender visibility, response time, approval discipline, and access to tamper-resistant audit records materially alter which attack chains remain feasible. A threat taxonomy should distinguish direct, indirect, multimodal, stored, and cross-session prompt injection; malicious tool descriptions, compromised outputs, and dependency poisoning; false-memory insertion, retrieval manipulation, and unauthorized persistence; and excessive agency involving broad goals, permissions, or irreversible actions. Agentic attack chains may proceed from reconnaissance to injection, instruction adoption, plan modification, tool selection, privilege use, memory persistence, impact, and evidence suppression. Unlike linear attacks, stages can recur as agents observe outputs and revise plans. Detection should map observable evidence to each transition, including provenance changes, unusual tool sequences, permission denials, memory writes, and transaction anomalies. Predictive optimization can support the prioritization of high-risk chains (Tonoyan et al., 2022c), adaptive controls can respond to changing behavior (Sanni et al., 2022), cross-boundary models illustrate interconnected consequences (Liadi, 2023a), and quantitative impact analysis helps compare mitigation strategies (Oduleye & Medon, 2023a). Taxonomies should record the target asset, injection carrier, persistence duration, required privilege, affected decision stage, and reversibility. A representative chain embeds instructions in a supplier document, induces credentialed retrieval, invokes an external transfer tool, stores a misleading justification in memory, and suppresses alerts through routine-looking actions. Defenses can then be assigned to chain preconditions and transitions rather than merely to final outcomes.

## 3. Prompt Injection and Tool-Poisoning Threats

### 3.1 Direct, Indirect, Multimodal, and Persistent Prompt Injection

Direct prompt injection occurs when a user explicitly instructs an agent to disregard governing policies, reveal protected information, or perform unauthorized actions. Indirect injection embeds comparable instructions in content the agent retrieves or observes, including emails, webpages, documents, database records, source-code comments, and tool responses. Because language models process data and instructions through a shared representational channel, syntactically persuasive content may be mistaken for authoritative control logic. Multimodal attacks extend this weakness to images, scanned documents, audio, QR codes, and concealed visual text processed through optical recognition or vision-language components. NLP research demonstrates the interpretive complexity of unstructured content (Atakpa et al., 2023), while cross-cultural communication research highlights how meaning changes across linguistic and contextual boundaries (Lilian et al., 2020). Security-operation architectures support behavioral correlation across heterogeneous inputs (Adegbite et al., 2024b), and breach-simulation frameworks provide

controlled methods for testing whether injected instructions survive ingestion and influence downstream actions (Dosunmu & Ogundele, 2024a).

Persistent injection occurs when hostile instructions are written into long-term memory, retrieval indexes, user profiles, summaries, caches, or workflow artifacts and subsequently influence unrelated sessions. Persistence converts a transient interaction into a durable control-plane compromise, particularly when an agent automatically summarizes conversations or treats retrieved organizational knowledge as trusted. Attackers may encode payloads conditionally—for example, instructing the agent to activate only when a finance tool becomes available—or fragment them across records to evade isolated-content screening. Defensive evaluation should test direct override requests, nested quotations, multilingual payloads, hidden image text, delayed triggers, encoded instructions, and cross-session reactivation. Secure-software testing principles support repeatable adversarial regression suites (Mbonu et al., 2021b), whereas attribution analysis helps determine which retrieved item altered an agent's decision (Sanni et al., 2022). Data-driven personalization illustrates why retained information requires controlled scope and validation (Yeboah et al., 2022), and algorithmic-accountability frameworks emphasize traceability for consequential automated decisions (Annan, 2024). Effective controls therefore require provenance labels, memory-write authorization, expiration policies, contextual isolation, and audit trails connecting every instruction-bearing artifact to resulting plans and actions.

### 3.2 Malicious Tool Descriptions, Compromised Connectors, and Deceptive Outputs

Agentic systems select tools partly from natural-language descriptions, parameter schemas, examples, and contextual metadata. A malicious tool provider can exploit this mechanism by inserting instructions that demand unnecessary data, suppress warnings, imitate trusted functions, or induce the agent to prefer the attacker's tool. Tool poisoning can also arise after legitimate registration when package dependencies, API documentation, schemas, endpoints, or connector configurations are modified. Enterprise connectors magnify exposure because they bridge agents to email, cloud storage, customer-management systems, repositories, payment platforms, and production databases. API-governance research supports maintaining ownership, versioning, authentication, and risk classifications for such interfaces (Aliliele et al., 2023b). Role-based privacy controls help constrain the records available through integrated business platforms (Badmus et al., 2024), identity-centric zero-trust models require verification at every service boundary (Ogbole et al., 2021), and integrated security operations support coordinated monitoring of connector identities and transactions (Ladapo et al., 2024). Accordingly, tool metadata should be signed, reviewed, immutable during execution, and separated from untrusted provider-supplied instructions. Deceptive outputs occur when a compromised or manipulated tool returns plausible but false observations, fabricated success messages, hidden instructions, substituted identifiers, or misleading risk assessments. For example, a poisoned payment connector might report that beneficiary verification succeeded while silently replacing the destination account. Because agents recursively plan from tool observations, one deceptive response can redirect subsequent calls and create cascading compromise. End-to-end visibility principles demonstrate the value of traceability across complex operational chains (Nnabueze et al., 2021), while forensic analytics provide methods for reconstructing suspicious communication sequences (Mbonu et al., 2021). Remote-monitoring research highlights the importance of validating observations against independent evidence (Dagodzo & Ahiaeke Patrick, 2020), and denial-of-service analysis shows that availability manipulation can be combined with deceptive routing or fallback behavior (Jimoh & Ahmed, 2024). Secure execution should therefore validate response schemas, bind outputs

cryptographically to tool identities, compare consequential results against independent sources, and reject unexpected instructions inside data fields. High-risk operations require transaction previews, parameter-level policy checks, human confirmation, and postcondition verification. Logs should preserve the selected tool version, request, response hash, credentials used, authorization decision, and resulting state change.

### 3.3 Instruction Hierarchies, Tool Authorization, and Injection-Resistant Execution

An instruction hierarchy distinguishes authoritative platform policies from developer constraints, user objectives, retrieved evidence, memory content, and tool outputs. Lower-authority content may supply facts but must not redefine higher-level rules, extend permissions, or alter approval requirements. Because a language model cannot reliably enforce this distinction through prompting alone, the hierarchy should be represented in the orchestration layer using typed context, provenance labels, immutable policy objects, and deterministic conflict-resolution rules. Governance research emphasizes assigning accountable decision rights for automated systems (Afrihyia et al., 2024), while regulatory-workflow models show how abstract requirements can be converted into executable checkpoints (Eyetsemitan et al., 2021). Vulnerability-governance architectures support mapping identified exposures to verified remediation (Adegbite et al., 2024a), and privacy-focused identity frameworks demonstrate the need to bind actions to validated principals (Kumuyi et al., 2024b). Retrieved documents should therefore remain untrusted evidence, quoted content should be non-executable, and any instruction requesting policy suspension should trigger rejection or escalation. Tool authorization should occur immediately before execution and evaluate the authenticated principal, delegated agent, requested capability, target resource, argument values, data sensitivity, operational purpose, and expected consequence. Tokens should be short-lived and scoped to one tool, transaction, resource set, and time window. Injection-resistant execution further requires parameter allowlists, egress restrictions, sandboxing, transaction limits, dry runs, idempotency controls, and independent postcondition checks. Smart-contract dispute models illustrate how explicit rules can constrain consequential transactions (Akomolafe et al., 2024b), while strategic-finance governance emphasizes oversight for cross-boundary decisions (Isiekwu et al., 2021). Proactive hazard-recognition systems support intervention before unsafe conditions become incidents (Obogo et al., 2021), and institutionalized safety practices demonstrate the importance of repeatable controls rather than discretionary caution (Obriki & Arumosoye, 2021). For example, an accounts-payable agent may prepare a transfer but should not execute it unless the beneficiary, amount, invoice, budget, and approver independently satisfy policy. If retrieved text requests a new beneficiary or bypassed approval, the executor should block the call irrespective of the model's rationale. Complete audit records must link the initiating objective, evidence, authorization decision, tool parameters, human approval, and verified outcome as seen in Table 2.

**Injection-Resistant Instruction and Tool-Control Framework**

| Control Area | Core Principle | Primary Risk Addressed | Required Safeguards |
|---|---|---|---|
| Instruction hierarchy | Platform policies outrank developer constraints, user requests, retrieved | Lower-authority content overriding policies or approval requirements | Typed context, provenance labels, immutable policies, deterministic conflict |

| Control Area | Core Principle | Primary Risk Addressed | Required Safeguards |
|---|---|---|---|
| | evidence, memory, and tool outputs | | resolution, and rejection of policy-suspension requests |
| Tool authorization | Revalidate authority immediately before every tool call | Unauthorized capabilities, resources, parameters, or consequential actions | Principal verification, least privilege, short-lived tokens, transaction-specific scopes, and consequence-aware approval |
| Secure execution | Treat model-generated actions as untrusted proposals | Prompt injection producing unsafe or irreversible operations | Parameter allowlists, sandboxing, egress restrictions, transaction limits, dry runs, idempotency, and postcondition verification |
| Accountability | Connect each action to its objective, evidence, authorization, and outcome | Untraceable decisions and ineffective incident investigation | Human approval for high-risk actions and complete, tamper-resistant audit records |

## 4. Memory Manipulation and Excessive Agency

### 4.1 Memory Poisoning, Cross-Session Contamination, and Retrieval Manipulation

Memory poisoning occurs when an attacker causes false instructions, fabricated facts, malicious preferences, or manipulated summaries to be stored as durable agent knowledge. The poisoned record may originate from direct user input, an indirectly injected document, a compromised tool response, or an automatically generated conversation summary. Unlike transient prompt injection, memory poisoning persists beyond the initiating interaction and can silently influence planning, retrieval, authorization recommendations, and tool selection. Cross-session contamination arises when information written during one user's task becomes available to another user, tenant, workflow, or agent because memory namespaces, access policies, or embedding indexes are insufficiently isolated. Continuous configuration monitoring is therefore essential for detecting unauthorized changes to cloud-hosted memory services (Aliliele et al., 2023a). Audit-analytics principles support reconstructing who wrote, modified, approved, or retrieved a record (Abetoh & Atakpa, 2024), while fraud-detection methods can identify anomalous write frequency, semantic inconsistency, and coordinated manipulation (Atakpa et al., 2024). Performance-intelligence models further support monitoring whether persistent memory improves or degrades operational outcomes over time (Adelanwa et al., 2024). Retrieval manipulation targets the mechanisms used to select contextual records rather than modifying the model directly. Attackers may create keyword-stuffed documents, adversarial embeddings, duplicate records, deceptive metadata, or artificially authoritative sources that rank above legitimate evidence. Manipulated records can be activated conditionally—for example, only when an agent processes payment, accesses executive data, or operates without human supervision. Defences should authenticate data sources, separate memory by tenant and purpose, constrain write privileges, scan stored content for executable instructions, and attach provenance, confidence, sensitivity, and expiration metadata to every record. Funnel-analysis methods can reveal where suspicious records disproportionately enter or dominate retrieval pipelines (Eyetsemitan et al., 2024b), while risk-based approval models

demonstrate how evidence quality should affect automated decisions (Eze et al., 2024b). Trust-measurement approaches are relevant when determining whether historical sources remain dependable (Komi, 2024), and dashboard frameworks support continuous visibility into memory writes, retrieval frequency, rejection rates, and cross-session access anomalies (Sanni & Atima, 2021b). Recovery should include quarantining contaminated indexes, invalidating derived summaries, rebuilding embeddings from verified sources, and replaying affected decisions against a trusted memory snapshot.

### 4.2 Overprivileged Agents, Goal Mis generalization, and Irreversible Actions

Overprivileged agents possess capabilities exceeding those required for their assigned objectives. Excess privilege may arise when agents inherit broad human service accounts, retain reusable credentials, receive unrestricted network access, or can invoke sensitive tools without transaction-specific authorization. The resulting risk is not limited to malicious behavior: an agent can cause substantial harm while faithfully pursuing an underspecified objective. Goal misgeneralization occurs when the model optimizes a proxy—such as minimizing cost, accelerating resolution, or increasing conversion—while disregarding safety, legality, fairness, or organizational intent. Cross-border payment risk models illustrate why transaction context must be evaluated before automated execution (Adesuyi et al., 2024). Capital-allocation models similarly demonstrate that optimization requires explicit constraints and accountable decision criteria (Lawal & Oduleye, 2021a). Quantitative risk architectures support assigning control requirements according to consequence and responsibility (Ike et al., 2024a), while risk-based auditing provides a mechanism for detecting deviations between approved objectives and executed actions (Akomolafe et al., 2023a). Irreversible actions include transferring funds, deleting production data, publishing confidential information, revoking identities, deploying code, terminating services, or sending legally binding communications. Such actions demand stronger controls than reversible searches, drafts, simulations, or recommendations. Agents should therefore receive staged capabilities: read before write, preview before commit, sandbox before production, and reversible operation before permanent modification. Simulation-based optimization can estimate the operational consequences of alternative actions before execution (Tonoyan et al., 2022b), while safety-leadership models emphasize accountable supervision for high-risk work (Arumosoye & Obriki, 2024). Risk-managed operational strategies demonstrate the importance of formal checkpoints in regulated environments (Ogbete et al., 2021), and transition-impact analysis highlights how apparently beneficial optimization can impose uneven downstream consequences (Komi & Adamolekun, 2024). A procurement agent, for example, may identify the lowest-priced supplier but should not issue an order without validating sanctions status, contractual authority, delivery risk, and budget ownership. Guardrails must enforce spending limits, allowed destinations, separation of duties, transaction timeouts, and independent confirmation. When objectives conflict or consequences cannot be confidently predicted, the correct agent behavior is to pause, preserve state, explain uncertainty, and request authorized human judgment.

### 4.3 Memory Isolation, Capability Control, Human Approval, and Safe Delegation

Memory isolation should separate records by tenant, user, workflow, agent role, task, sensitivity, and retention period. Isolation must operate at storage, embedding, retrieval, cache, logging, and backup layers because access controls applied only to the visible database can be bypassed through shared vector indexes or derived summaries. Each memory write should require an authenticated writer, declared purpose, provenance record, sensitivity classification, expiration rule, and

authorization decision. Risk-based information architectures demonstrate how data access can be aligned with operational consequence (Mbonu et al., 2021a), while quantitative compliance models support assigning controls according to measurable exposure (Akomolafe et al., 2023b). Safety-governance frameworks emphasize formal ownership of protective controls (Obogo et al., 2022), and regulated procurement models show why authorization must remain connected to policy throughout a transaction (Okonkwo et al., 2021). Sensitive memories should be encrypted with tenant-specific keys, excluded from global learning, and retrieved only when both the user and task possess legitimate need. Capability control translates least privilege into narrowly scoped, short-lived, and revocable permissions. An agent should receive only the tools, records, parameters, and transaction limits required for its current task. Human approval should be consequence-sensitive rather than universally applied: low-risk reversible operations can proceed automatically, whereas financial transfers, destructive changes, external communications, and privilege escalation require informed confirmation. Supplier-governance models illustrate the need to validate delegated parties and their responsibilities (Akin-Oluyomi et al., 2024), while contractor-compliance systems demonstrate that delegation does not transfer accountability (Obogo et al., 2021). Process-redesign research supports placing approval checkpoints where they control risk without introducing unnecessary delay (Oyeleye et al., 2022), and workforce-training models emphasize that reviewers must understand the hazards they authorize (Obriki et al., 2022a). Safe delegation between agents requires attenuated credentials, explicit objectives, bounded subtasks, prohibited-action lists, time and cost budgets, and return-only results rather than inherited authority. A parent agent must verify a delegate's identity, provenance, outputs, and policy compliance before acting on them. Delegation chains should remain traceable, depth-limited, and terminable, with every agent unable to grant permissions broader than those it legitimately possesses.

## 5. Defense Architecture, Evaluation, and Enterprise Deployment

### 5.1 Runtime Policy Enforcement, Monitoring, Sandboxing, and Transactional Safeguards

Runtime policy enforcement places deterministic controls between an agent's proposed action and the enterprise resource affected by it. The enforcement layer should evaluate the authenticated user, delegated agent identity, requested tool, arguments, target object, data classification, transaction value, operational purpose, and current risk state. Policies must operate independently of the language model so that persuasive prompt injections cannot redefine permissions. Identity and access-management research supports integrating authorization consistently across hybrid and multicloud services (Mbonu et al., 2020), while intrusion-prevention models demonstrate the value of blocking suspicious activity before impact occurs (Dosunmu & Ogundele, 2020). Multi-stakeholder governance frameworks emphasize clear decision authority across integrated operations (Eyetsemitan et al., 2020), and internal-audit systems support traceable verification of whether controls operated as intended (Obogo et al., 2020a). Runtime rules should impose parameter allowlists, spending limits, destination restrictions, rate limits, data-loss controls, approval requirements, and explicit prohibitions against credential disclosure or policy modification. Monitoring should correlate prompts, retrieved records, plans, tool selections, authorization decisions, memory operations, network activity, and resulting state changes. Sandboxing further limits impact through isolated filesystems, restricted network egress, ephemeral credentials, read-only resources, CPU and memory quotas, and automatic termination. Human-error models show why system design must anticipate mistakes rather than assume perfect operator or agent behavior (Obriki & Arumosoye, 2020). Risk-management approaches support

proportionate controls for high-consequence actions (Obogo et al., 2020b), predictive-maintenance principles encourage early identification of abnormal operational patterns (Sunday et al., 2020), and technology-rollout research highlights the importance of phased deployment and performance validation (Sanni et al., 2020c). Transactional safeguards should use previews, dry runs, idempotency keys, two-phase commits, rollback points, and postcondition verification. For example, a payment should remain provisional until beneficiary identity, invoice details, amount, budget, and approval are independently verified. If execution fails, the system should restore a known-good state, preserve forensic evidence, invalidate exposed credentials, and prevent automated retries from multiplying the original harm.

### 5.2 Security Benchmarks, Attack Simulations, Metrics, and Red-Team Evaluation

Agentic-security benchmarks should reproduce complete workflows rather than test isolated model responses. Representative scenarios should cover direct and indirect prompt injection, multimodal payloads, poisoned memory, malicious tool metadata, compromised connector outputs, privilege escalation, unsafe delegation, data exfiltration, and irreversible transactions. Test environments should vary model, prompt architecture, memory configuration, tool privileges, data sensitivity, and approval policy. Safety-audit maturity models demonstrate the value of evaluating controls at progressive capability levels rather than issuing binary pass-or-fail judgments (Adeyelu & Dagodzo, 2024a). Incident-prevention models support testing whether safeguards interrupt causal pathways before harm occurs (Obogo et al., 2021). Interpretable predictive methods show why evaluators should identify the evidence behind detection outcomes (Komi & Adamolekun, 2021), while measurement frameworks emphasize constructing metrics that reflect operational objectives (Sanni et al., 2020a). Benchmark records should preserve attack prerequisites, payloads, expected secure behavior, observed actions, tool traces, policy decisions, and final consequences. Core metrics should include attack success rate, unsafe-action rate, policy-violation rate, sensitive-data disclosure, poisoned-memory persistence, cross-session propagation, tool-selection manipulation, detection precision, recall, false-positive rate, and time to containment. Operational measurements should additionally capture task completion, latency, human-review burden, token consumption, rollback success, and residual business impact. Forecasting research supports evaluating performance across changing conditions rather than a single static dataset (Tonoyan et al., 2021a), while longitudinal evaluation demonstrates the importance of measuring sustained effectiveness (Dada et al., 2024). Sensor-based fault detection provides an analogy for distinguishing genuine anomalies from routine variation (Sunday & Omoegun, 2022), and data-driven hazard monitoring highlights the importance of timely intervention (Adeyelu & Dagodzo, 2024b). Red teams should combine linguistic, technical, social-engineering, and enterprise-domain expertise. Exercises must include adaptive attackers who observe denials, rephrase payloads, poison secondary channels, and exploit approval fatigue. Results should report performance by attack class and consequence level rather than one aggregate score, and every discovered failure should become a reproducible regression test linked to a named control owner and remediation deadline.

### 5.3 Comparative Defenses, Deployment Case Studies, and Implementation Guidance

No single defense adequately addresses the interaction among prompt injection, tool poisoning, memory manipulation, and excessive agency. Prompt filters can reject obvious malicious instructions but remain vulnerable to paraphrasing, encoding, and indirect delivery. Model-based classifiers provide semantic coverage but introduce false positives and may share the underlying

model's weaknesses. Provenance controls, instruction separation, least-privilege authorization, sandboxing, human approval, and transactional verification address different points in the attack chain and should therefore be evaluated as complementary layers. Predictive-risk models illustrate how multiple operational indicators can be combined for early intervention (Aliliele et al., 2023c), while business-intelligence applications demonstrate the importance of integrating heterogeneous enterprise evidence (Akinleye et al., 2023). Visualization frameworks support analyst understanding of complex agent activities (Babatope et al., 2023), and reliability-latency research highlights unavoidable trade-offs between additional security checks and workflow responsiveness (Asiedu & Quainoo, 2024). Comparative studies should report both marginal protection from each control and cumulative protection from layered configurations.

Deployment guidance should begin with bounded case studies in which agents have narrow objectives, read-only data, simulated tools, and reversible outputs. Remote infrastructure models demonstrate why local autonomy must be matched by monitoring and safe fallback mechanisms (Falegan & Aniebonam, 2024), while materials-readiness frameworks emphasize verifying dependencies before operational execution (Okonkwo et al., 2021). Regulatory-harmonization research highlights the need to translate jurisdiction-specific obligations into consistent controls (Eze et al., 2024a), and comparative financing studies show that context determines which intervention remains practical and effective (Komi & Adeniji, 2024a). A staged enterprise implementation should inventory agent workflows, classify data and tools, map trust boundaries, assign risk tiers, implement external policy enforcement, and establish immutable audit logging. Organizations should then conduct adversarial testing, define human-approval thresholds, rehearse containment and rollback, and deploy initially through shadow or recommendation-only modes. Production promotion should require demonstrated resistance to representative attacks, acceptable false-positive rates, reliable transaction recovery, and named ownership for policy maintenance. Continuous monitoring must detect model, tool, connector, memory, and workflow drift because a secure launch configuration does not guarantee sustained security after dependencies, permissions, or operating conditions change.

## 6. Governance, Research Challenges, and Future Directions

### 6.1 Privacy, Accountability, Auditability, and Incident-Response Governance

Agentic enterprise systems require privacy governance that extends beyond model inputs to encompass retrieved documents, persistent memories, intermediate reasoning artifacts, tool parameters, connector responses, execution logs, and delegated-agent communications. Data minimization should restrict each agent to information necessary for its current task, while purpose limitation should prevent records retrieved for one workflow from being reused elsewhere without authorization. Sensitive attributes must be classified, encrypted, access-controlled, and assigned retention periods. Memory deletion should propagate to embeddings, caches, summaries, backups, and derivative records. Privacy-enhancing controls should include scoped retrieval, field-level redaction, confidential-computing environments, tenant-specific encryption keys, and automated prevention of sensitive-data transmission to unauthorized tools.

Accountability requires every consequential action to be attributable to an authenticated user, responsible business owner, agent version, policy configuration, tool identity, and approval decision. Audit records should capture the initiating objective, instructions received, evidence retrieved, memory consulted, plan generated, permissions evaluated, tool arguments, outputs, state changes, and postcondition checks. Logs must be tamper-evident, time-synchronized, searchable, and protected from the agent being monitored. Incident-response procedures should define triggers

for suspending execution, revoking credentials, isolating connectors, freezing memory writes, preserving evidence, and reverting transactions. Investigators must determine whether compromise originated through prompt injection, tool poisoning, retrieval manipulation, excessive privilege, or unsafe delegation. For example, after an unauthorized supplier payment, responders should quarantine the relevant agent, invalidate payment credentials, identify contaminated memories, reconstruct the tool-call chain, and verify related transactions. Governance should conclude each incident with root-cause analysis, affected-party notification, control remediation, regression testing, and formally approved restoration.

### 6.2 Standardization, Reproducibility, and Emerging Research Opportunities

Standardization is necessary because agentic-security claims currently depend heavily on proprietary models, undocumented prompts, changing tools, and incomparable evaluation environments. A common reporting specification should describe the foundation model and version, orchestration logic, instruction hierarchy, memory architecture, retrieval configuration, tool schemas, permission scopes, approval policies, sandbox restrictions, and external dependencies. Threat descriptions should record the attacker's access, knowledge, payload carrier, persistence mechanism, required privilege, targeted asset, expected impact, and success criteria. Benchmarks should provide machine-readable task definitions, reproducible attack traces, deterministic tool simulators, seeded datasets, policy configurations, and ground-truth secure outcomes. Reporting only aggregate attack success obscures important differences among languages, modalities, tools, user roles, and consequence levels.

Reproducibility also requires immutable experiment manifests, containerized execution environments, signed artifacts, version-controlled prompts, and complete logs of model and tool interactions. Where proprietary models prevent exact replication, studies should expose behavioral specifications and evaluate multiple model families under equivalent controls. Emerging research should investigate formal verification of tool-call policies, information-flow tracking across memory and delegation chains, adversarially robust retrieval, cryptographic provenance for tool outputs, and capability systems that prevent privilege amplification. Additional opportunities include memory-poisoning detectors that identify semantic contradictions, causal methods that attribute unsafe actions to particular context elements, and adaptive sandboxes that tighten restrictions when uncertainty rises. Multimodal attacks require benchmarks involving diagrams, audio, video, document layouts, and concealed visual instructions. Human factors also demand attention: approval interfaces should communicate consequences clearly and resist habituation, automation bias, and approval fatigue. Future testbeds should model realistic enterprise workflows involving email, code repositories, financial systems, cloud administration, and customer records. Progress should ultimately be measured by reduced consequential harm under adaptive attack, not merely by improved refusal rates on static prompts.

### 6.3 Conclusions and Implications for Secure Agentic Enterprise Systems

The review establishes that agentic AI security cannot be reduced to prompt filtering or model alignment. Enterprise agents combine probabilistic reasoning with persistent memory, external data, delegated identities, and tools capable of changing organizational state. This combination creates interconnected risks: prompt injection can alter planning, poisoned tools can falsify observations, manipulated memory can preserve malicious influence, and excessive authority can convert reasoning errors into irreversible consequences. Security must therefore be implemented as a system property spanning context ingestion, planning, retrieval, authorization, execution,

monitoring, recovery, and governance. The language model should propose actions, but deterministic infrastructure should decide whether those actions are permitted.

Secure deployment requires typed instruction boundaries, authenticated provenance, isolated memory, least-privilege capabilities, parameter-level authorization, restricted execution environments, transaction previews, independent verification, and consequence-sensitive human approval. Organizations should begin with low-risk, reversible workflows and progressively expand authority only after adversarial evaluation demonstrates adequate control effectiveness. High-impact functions, including financial transfers, production deployment, identity administration, legal communication, and destructive data operations, should retain separation of duties and reliable rollback mechanisms. Continuous monitoring must detect changes in prompts, models, tools, connectors, permissions, memory contents, and operating conditions. Incident response should support immediate suspension, credential revocation, memory quarantine, forensic reconstruction, and restoration from trusted state.

The central implication is that useful agency and strong control are compatible when authority is deliberately bounded. Enterprises should treat agents as untrusted decision components operating within trusted enforcement architectures, not as autonomous substitutes for governance. Future systems should make every consequential action attributable, explainable, reversible where possible, and independently verifiable. This approach enables organizations to obtain the productivity benefits of agentic workflows while limiting systemic exposure to manipulation, cascading errors, and unauthorized action.

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