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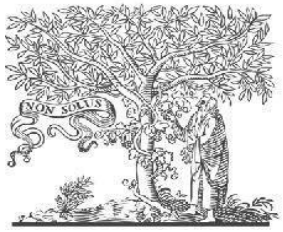

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Abuse Case Detection Coverage Using MITRE ATT&CK Framework

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Abstract

With the growing complexity of cloud infrastructure environments, robust and systematic threat detection has become a necessity for organizations operating across diverse cloud platforms. This paper leverages the MITRE ATT&CK Framework to enhance abuse case detection coverage, offering a structured approach to identifying and mitigating threats. By systematically mapping Tactics, Techniques, and Procedures (TTPs) to common deployment models such as compute, Kubernetes, serverless, and storage, we aim to ensure broad and proactive threat detection coverage.

The Cloud Infrastructure Runtime Threat Detection Platform integrates MITRE ATT&CK mappings across major platforms—Amazon Web Services (AWS), Google Cloud Platform (GCP), Microsoft Azure, and Colocation (COLO)—to identify vulnerabilities unique to each environment. Prioritizing TTPs based on severity, this approach addresses critical tactics such as Privilege Escalation, Defense Evasion, and Command and Control, which are key to reducing exposure to advanced threats. Actionable mapping provides teams with the tools necessary to improve runtime security, detect anomalies, and respond efficiently to abuse cases.

This paper also explores practical challenges organizations face, including multi-platform complexity, dynamic scaling environments, and false positives in detection. Case studies are presented to illustrate real-world scenarios, such as Kubernetes misconfigurations and privilege escalation, demonstrating the importance of runtime monitoring and proactive detection mechanisms. Additionally, we highlight future directions such as the integration of AI-based anomaly detection, real-time threat intelligence feeds, and cross-cloud visualization dashboards to improve adoption and scalability of threat detection solutions.

By adopting the MITRE ATT&CK Framework, organizations can align their threat detection strategies with a globally recognized knowledge base, enabling a systematic, scalable, and proactive approach to abuse case detection in distributed cloud environments.

Keywords: MITRE ATT&CK, Cloud Infrastructure, Runtime Threat Detection, Abuse Case Detection, TTP Mapping, Kubernetes Security, Serverless Security, Compute Security, Cloud Security, Threat Detection Framework

Introduction

The rapid proliferation of cloud computing technologies and their broad adoption across industries have dramatically transformed the IT landscape, offering organizations unprecedented scalability, flexibility, and cost-effectiveness. Yet, as enterprises continue to migrate critical workloads and sensitive data into the cloud, they inevitably face a host of new security challenges. Modern cloud infrastructure environments, encompassing an ever-growing variety of services and architectures, present complex and dynamic attack surfaces that malicious actors are increasingly exploiting [1][2]. Understanding and mitigating potential threats in these environments calls for robust, systematic approaches that can keep pace with constantly evolving adversarial tactics and techniques.

One of the most prominent frameworks guiding security teams in their efforts to understand and respond to these threats is the MITRE ATT&CK Framework. Developed as a globally recognized knowledge base, MITRE ATT&CK enumerates a comprehensive set of adversarial Tactics, Techniques, and Procedures (TTPs) observed in real-world cyberattacks [3]. Unlike conventional signature-based detection methodologies, the ATT&CK framework emphasizes behavioral indicators, enabling defenders to reason about the "how" and "why" behind attacks rather than focusing solely on isolated Indicators of Compromise (IOCs). The applicability of the ATT&CK model extends across diverse IT ecosystems, and it has become a cornerstone for building strategic detection coverage, aligning threat modeling efforts, and closing existing security gaps [4]. By employing this framework, organizations can shift from reactive, ad-hoc detection strategies towards more proactive, risk-informed approaches that adapt as threat landscapes evolve.

The complexity of modern cloud infrastructure environments poses significant challenges for security practitioners. Today's cloud deployments frequently span multiple providers—such as Amazon Web Services (AWS), Google Cloud Platform (GCP), and Microsoft Azure—as well as colocation (COLO) facilities that maintain legacy on-premises resources. Moreover, organizations are increasingly embracing a wide array of deployment models, from traditional compute instances to containerized workloads on Kubernetes clusters, serverless computing platforms where code executes without the need to manage underlying servers, and distributed storage services that blur the boundaries between infrastructures [5]. Each of these environments brings unique configurations, operational paradigms, and vulnerability profiles. For instance, the ephemeral nature of serverless functions may obscure standard telemetry collection methods, and the complexity of Kubernetes orchestration can introduce misconfigurations that attackers exploit. Similarly, distributed storage systems and intricate Identity and Access Management (IAM) controls can inadvertently expand the attack surface if not rigorously monitored and tuned. As these diverse platforms and configurations converge, defenders must grapple with a multifaceted threat landscape that strains the limits of traditional detection capabilities [6].

Against this backdrop, there is a growing need for an integrated, systematic method to map, prioritize, and enhance runtime threat detection across various cloud environments. By leveraging the MITRE ATT&CK Matrix as a guiding reference, security teams can break down the complexity of cloud platforms into a set of well-defined TTPs. These TTPs can then be analyzed, ranked by severity or potential impact, and associated with appropriate detection and response measures. Such a methodical alignment allows defenders to identify coverage gaps, strengthen detection rules, and more effectively allocate resources to the highest-risk areas. Importantly, this approach also helps organizations maintain resilience in the face of increasingly sophisticated threat actors who frequently

pivot between different cloud platforms and resource types. The result is a more holistic, structured security posture that provides better visibility into attacker behaviors and supports more timely and effective threat mitigation.

This paper aims to address these imperatives by providing a detailed mapping of the MITRE ATT&CK Matrix across various cloud deployment models, encompassing compute, containerization, serverless architectures, and storage solutions. In doing so, it focuses on identifying where current detection capabilities may fall short and offers a practical methodology to prioritize TTPs. Additionally, this research highlights how augmenting threat detection strategies through the lens of the ATT&CK Matrix leads to more comprehensive abuse case coverage. By doing so, organizations can not only improve their runtime threat detection capabilities but also proactively reduce the risk of breaches, data exfiltration, and service disruptions.

Beyond the technical mapping and prioritization, this paper also considers how practical, real-world constraints influence the ultimate efficacy of such frameworks. Case studies provide contextual examples of how organizations have successfully employed ATT&CK-driven approaches to improve detection fidelity, reduce false positives, and speed up response times. Conversely, the challenges encountered—ranging from the integration with legacy security tools to the complexities of maintaining coverage across hybrid and multi-cloud environments—shed light on the real-world trade-offs that security teams must navigate. Such insights illuminate opportunities for future work, including enhanced automation techniques, improved telemetry pipelines, and tighter integration of ATT&CK with emerging industry standards. By rigorously documenting both successes and limitations, this paper aims to bridge the gap between theoretical frameworks and operational realities.

Ultimately, the goal of this paper is to help practitioners and researchers better understand how to apply and tailor the MITRE ATT&CK framework to the unique demands of modern cloud infrastructures. By doing so, it empowers organizations to identify and mitigate threats earlier in the attack lifecycle, strengthen their detection posture across various ecosystems, and stay ahead of adversaries who continuously evolve their methods. In an era defined by rapid digital transformation, leveraging a structured, knowledge-driven approach can serve as a significant force multiplier in the ongoing effort to secure complex, heterogeneous cloud environments.

SCOPE

The Cloud Infrastructure Runtime Threat Detection Platform focuses on detecting abuse cases across a variety of cloud platforms and deployment/storage models. The primary scope includes:

A. Cloud Platforms

- Amazon Web Services (AWS) [7]
- Google Cloud Platform (GCP) [8]
- Microsoft Azure [9]
- Colocation (COLO) [10]

B. Top Deployment/Storage Models

- **Compute**: Includes AWS EC2, GCP VM. Focuses on vulnerabilities like misconfigurations for initial access and persistence [11].
- **Kubernetes**: Includes AWS EKS, GKE, and other Kubernetes clusters. Key abuse cases include malicious pod deployments and API-based attacks [12].
- **Serverless**: Applies to AWS Lambda, Azure Functions, and Google Cloud Functions. TTPs include IAM misconfigurations and unauthorized access [13].
- **Storage**: Focuses on unauthorized access to services such as AWS S3 and Google Cloud Storage [14].

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PRIORITIZATION OF MITRE ATT&CK TACTICS

The severity of MITRE ATT&CK Tactics is prioritized to ensure the platform focuses on high-impact abuse cases. The categories are:

A. Critical Severity

1. Privilege Escalation
2. Defense Evasion
3. Command and Control
4. Exfiltration

B. High Severity

1. Initial Access
2. Execution
3. Persistence
4. Credential Access

C. Medium Severity

1. Discovery
2. Lateral Movement

D. Low Severity

1. Collection

IV. MITRE ATT&CK MAPPING ACROSS DEPLOYMENT MODELS

A. Compute Example

Tactic	Technique	Description
Initial Access	Exploit Public-Facing App	Exploiting misconfigured EC2 instances.
Persistence	Scheduled Tasks/Jobs	Automating malicious access persistence.

B. Kubernetes Example

Tactic	Technique	Description
Initial Access	Exploit Misconfigured Services	API-based attacks on Kubernetes clusters.
Persistence	Create Malicious Pods	Rogue pods deployed to exfiltrate data.

CASE STUDY: EXPLOITING KUBERNETES MISCONFIGURATIONS

Scenario:
In this illustrative case study, a sophisticated adversary targets an organization's Kubernetes environment—one of the most commonly used container orchestration platforms in modern cloud deployments—by capitalizing on a misconfigured Kubernetes dashboard. This dashboard, intended to simplify cluster management and observability, had been inadvertently exposed with insufficient authentication or authorization controls. Such a vulnerability often arises when teams rapidly provision and scale services without adequately revisiting and hardening initial configurations.

The attacker, after performing routine reconnaissance, identified that the dashboard lacked proper access restrictions. With this foothold, the adversary authenticated to the cluster's dashboard and gained visibility into its resources. Exploiting administrative privileges inadvertently granted to the dashboard's service account, the attacker proceeded to create malicious pods. These pods were configured with elevated permissions, granting them access not only to containerized applications running within the cluster but also to associated storage volumes and databases connected to the environment. Over time, the threat actor methodically navigated the cluster, discovering sensitive customer data stored in backend databases that supported the organization's customer-facing applications.

By incorporating additional techniques—such as secret extraction from Kubernetes Secrets and leveraging service account tokens for lateral movement—the adversary's activities went largely undetected in the early stages. Eventually, as the attacker exfiltrated sensitive customer data, indicators of compromise emerged, but by that point significant damage had been done. This scenario underscores the importance of defense-in-depth strategies, especially considering that Kubernetes often interacts with other cloud-native services, thereby widening the potential attack surface. The misconfigured dashboard effectively became a single point of failure, enabling the adversary to bypass several layers of standard security controls.

Detection Mechanism:
To effectively identify and respond to such an intrusion, organizations must rely on a multi-layered detection and monitoring strategy that aligns with MITRE ATT&CK Tactics, Techniques, and Procedures (TTPs). Mapping the incident to the "Initial Access" tactic—specifically the technique of "Exploiting Misconfigured Services"—can guide defenders on where to focus their telemetry and alerting. For instance, runtime security tools capable of monitoring container behavior at the kernel level or through sidecar agents are critical. These tools can identify anomalous pod activities, such as pods requesting privileged credentials, mounting unauthorized volumes, or connecting to internal APIs that typically should not be accessed by the given identity.

Moreover, logging and monitoring the Kubernetes API server activity provides invaluable insights. By comparing normal baseline activities (e.g., routine deployments, scaling events) against suspicious actions (e.g., creation of pods with unexpected configurations or request patterns), defenders can rapidly detect anomalies. Detailed audit logs from the Kubernetes API, combined with proper aggregation and correlation mechanisms, enable early detection of irregular administrative actions that deviate from established Infrastructure-as-Code (IaC) templates or Continuous Integration/Continuous Deployment (CI/CD) pipelines.

Detection solutions might include policy enforcement engines that continuously verify the compliance of new deployments against known good configurations, alerting or blocking deployments that grant excessive permissions. Integration with cloud-native tools that leverage eBPF (Extended Berkeley Packet Filter) for deep observability within containers can reveal unexpected process executions, suspicious network connections, and data flows that suggest exfiltration attempts.

Outcome:
In this particular case study, the early detection of anomalous pod activity and unauthorized dashboard access proved critical. Rather than allowing the attacker to traverse laterally within the Kubernetes cluster unimpeded, defenders swiftly detected the presence of unusual pods running with elevated privileges. Security teams isolated and terminated these pods, revoking compromised service account tokens and updating the misconfigured dashboard settings. As a result, the immediate damage was contained before the attacker could pivot deeper into internal systems or exfiltrate a larger volume of sensitive data.

This containment minimized both the scale and the duration of the breach, ultimately reducing the potential business and reputational impact. The lessons learned from this incident reinforced the need for continuous posture management, adherence to the principle of least privilege, and the deployment of advanced runtime detection tools. As a direct consequence, the organization implemented stricter access controls on dashboards, enforced encryption of secrets at rest, and established more rigorous baseline policies for pod creation—all of which serve as deterrents against future attempts to exploit similar misconfigurations.

CHALLENGES IN IMPLEMENTATION

Despite the value of MITRE ATT&CK-driven approaches and robust runtime detection in cloud environments, practitioners face a number of formidable challenges in their operationalization. These hurdles must be understood and addressed to ensure that detection and response strategies remain both effective and sustainable.

Dynamic Cloud Environments: A core challenge involves the inherently dynamic and elastic nature of modern cloud infrastructures [15]. Cloud-native applications continuously scale in and out based on demand, while configuration updates, service redeployments, and resource provisioning happen at a rapid pace. These frequent changes can complicate efforts to maintain accurate baselines, as what is considered "normal" can shift rapidly. Traditional security frameworks and static detection rules may fail to keep up with such fluidity, resulting in blind spots or delayed detection. For instance, a surge in network traffic previously considered anomalous might become routine following a business-driven scaling event. Similarly, ephemeral workloads that live only minutes or seconds make persistent logging and tracing challenging. Adapting detection methodologies to handle such volatility is critical, often requiring increased automation, machine learning-driven anomaly detection, and continuous recalibration of what constitutes normal behavior within the environment.

Multi-Platform Complexity: The complexity further intensifies in multi-cloud or hybrid environments, where organizations leverage multiple platforms such as AWS, Google Cloud Platform (GCP), Microsoft Azure, and legacy Colocation (COLO) environments [16]. Each platform introduces distinct APIs, logging mechanisms, IAM systems, and network architectures. As a result, building detection capabilities that are both comprehensive and platform-agnostic becomes a non-trivial task. Security teams must invest in tools that can ingest and normalize data from heterogeneous sources, correlating events across environments to identify compound indicators of compromise. Additionally, they must remain cognizant of platform-specific attack vectors: An adversary might exploit an IAM misconfiguration in AWS, a vulnerable firewall rule in Azure, and an improperly secured storage bucket in GCP. Achieving holistic visibility and consistent detection coverage requires both broad expertise and mature tooling that can unify and harmonize telemetry across diverse ecosystems.

False Positives and Alert Fatigue: A key operational challenge lies in finding the right balance between sensitivity and specificity in detection rules. Overreliance on static, signature-based rules without leveraging behavioral or machine learning-enhanced methods can lead to excessive false positives [17]. Every detection alert demands time and effort from security analysts, and if too many alerts are incorrect or trivial, analysts risk suffering alert fatigue. This fatigue can cause important signals to be overlooked or deprioritized. Enhancing detection logic with behavioral analytics, leveraging anomaly detection to identify truly unusual patterns rather than trivial changes, and continuously tuning detection thresholds can help mitigate this issue. Additionally, integrating threat intelligence feeds and applying context-aware filtering allows defenders to focus on genuinely suspicious activities rather than benign operational noise.

To address these challenges, organizations are increasingly turning to automation and orchestration solutions. Automated workflows can enrich alerts with contextual data, execute predefined response actions, and leverage machine learning models to refine detection over time. Implementing "defense as code" through Infrastructure-as-Code pipelines ensures that changes to security configurations can be tested, approved, and deployed systematically. This approach both minimizes human error and ensures a consistent, repeatable security posture.

In sum, while adopting MITRE ATT&CK methodologies and advanced runtime detection techniques can significantly enhance threat detection coverage, success largely depends on how well organizations navigate these operational hurdles. Staying ahead in this evolving landscape involves embracing continuous improvement, investing in cross-platform detection capabilities, and striking a careful balance between thoroughness and efficiency. Overcoming these challenges is an ongoing endeavor—one that necessitates not only technical acumen but also organizational commitment, process refinement, and strategic vendor partnerships.

Future Work

The rapid evolution of cloud-native technologies, coupled with the constant innovation of adversarial techniques, necessitates a forward-looking approach to runtime threat detection. While the current alignment of detection strategies with the MITRE ATT&CK framework provides a solid foundation, several areas stand out as promising avenues for future exploration and development. Each area aims to address emerging challenges while capitalizing on new methodologies and technologies that can raise the bar for security posture and resilience.

Automation with AI:

One of the most promising frontiers in cloud threat detection involves incorporating advanced Artificial Intelligence (AI) and Machine Learning (ML) models. Automation through these techniques enables the detection of subtle anomalies that might otherwise escape rule-based approaches. For example, ML-driven anomaly detection can identify statistically abnormal activities, such as sudden spikes in network traffic, unexpected sequence of API calls, or unusual authentication patterns. Beyond static threshold-based rules, behavioral models can be continuously retrained on historical data, adapting dynamically to evolving workloads, deployment topologies, and organizational usage patterns. Over time, these systems become more effective at differentiating benign environmental changes (such as normal traffic growth due to seasonal peaks) from malicious behaviors (like exfiltration attempts under the guise of normal operations). Additionally, AI-driven approaches can surface complex, multi-step attack chains, correlating seemingly unrelated events across multiple services and cloud providers. By automating aspects of triage and investigation, these intelligent systems can free up security analysts to focus on higher-level strategic tasks, such as refining detection policies or researching new threats.

Integration with Threat Feeds:

The increasingly interconnected nature of today's digital ecosystem means that no organization is an island when it comes to security. To stay ahead of attackers, defenders must look beyond their own logs and telemetry, enriching their detection pipelines with external threat intelligence feeds. These feeds provide valuable context on current Indicators of Compromise (IOCs), known bad IP addresses or domains, and newly discovered vulnerabilities or exploit techniques. By seamlessly integrating threat intelligence into detection workflows, organizations can prioritize certain types of alerts, correlate observed activities with known attacker playbooks, and preemptively block connections to suspicious endpoints. Over time, as threat intelligence sources improve in quality and relevance, defenders can automate aspects of their threat hunting processes, instantly flagging any activity that matches or closely resembles known malicious patterns. This proactive stance not only raises detection efficacy but also shortens the window of opportunity for adversaries to operate undetected.

Cross-Cloud Threat Visualization:

As organizations become more fluid in their utilization of various cloud platforms—spreading workloads across AWS, Azure, GCP, and COLO environments—the challenge of maintaining consistent visibility grows exponentially. A single pane of glass that can visualize threats across multiple clouds and services is crucial. By building unified dashboards capable of normalizing and presenting data from disparate sources, security teams can more easily identify complex, cross-platform attack campaigns.

Such visualization capabilities could include dynamic graph-based models of attacker movement, heat maps showing regions of concentrated malicious activity, and timeline views of how threats evolve over time. Integrating these capabilities with MITRE ATT&CK techniques would allow analysts to quickly pinpoint which part of the kill chain the adversary currently occupies. This holistic perspective enables more informed, strategic decisions that can contain an intrusion before it escalates. Additionally, improved visualization empowers less experienced analysts to rapidly understand complex security scenarios, thereby democratizing the incident response process and reducing reliance on scarce, highly specialized skill sets.

Adoption of the MITRE D3FEND Framework:

While MITRE ATT&CK has emerged as a powerful lens for understanding and categorizing adversarial behavior, the MITRE D3FEND framework offers a complementary perspective focused on defensive techniques [18]. By aligning security measures and detection capabilities with D3FEND, practitioners can ensure a more robust and systematic approach to mitigation. D3FEND maps defensive capabilities to ATT&CK techniques, aiding organizations in identifying which countermeasures are most effective against particular TTPs. Incorporating D3FEND into detection workflows will help teams not only recognize which threats they can detect but also determine how to respond optimally. This alignment provides a feedback loop: as new TTPs emerge and are cataloged in ATT&CK, defenders can look up corresponding D3FEND controls and quickly adapt their strategies. Over time, such synergy between ATT&CK and D3FEND can catalyze the evolution of best practices, tooling enhancements, and improved interoperability among security solutions.

Conclusion

The dynamic world of cloud computing continues to reshape how organizations conduct business, deliver services, and store critical data. With this transformation come new challenges in ensuring that security postures remain strong, adaptive, and prepared to counter a constantly shifting threat landscape. The MITRE ATT&CK framework provides a critical foundation for building a structured approach to threat detection and response, offering a consistent language and taxonomy for describing adversarial behaviors. By mapping detection techniques, logging strategies, and response playbooks directly to ATT&CK tactics and techniques, organizations can achieve more comprehensive coverage against a wide range of potential attacks.

This work has demonstrated how leveraging MITRE ATT&CK can systematically enhance abuse case detection coverage across diverse cloud platforms and deployment models. By evaluating real-world use cases—such as an adversary exploiting Kubernetes misconfigurations—and extracting lessons learned, defenders gain insight into the practical, operational nuances of threat detection in complex, multi-faceted environments. Prioritizing techniques and focusing on runtime threat detection tools ensures not only timely alerts but also meaningful, actionable information that enables security teams to respond decisively and effectively.

Nonetheless, the complexity of modern architectures, the prevalence of multi-cloud strategies, and the ubiquity of ephemeral workloads present ongoing challenges. As clouds scale elastically, the baseline for “normal” behavior shifts. As organizations adopt new platforms, each with unique configurations and APIs, correlation and normalization become more difficult. And as attackers refine their techniques, the fidelity and speed of detections must continuously improve. The keys to overcoming these challenges lie in continuous improvement, ongoing education, and strategic investments in emerging technologies.

Future directions in this domain point towards even more intelligent and integrated solutions. Incorporating AI and ML can automate aspects of anomaly detection,

enabling adaptive responses to evolving threats. Integrating continuous threat intelligence feeds into detection pipelines helps security teams stay ahead of adversaries who shift tactics in near-real time. Unified dashboards and visualization tools improve situational awareness, enabling defenders to reason about complex multi-cloud attacks holistically. Moreover, embracing frameworks like MITRE D3FEND ensures that defenders have a structured method for correlating attacks and defenses, making the security ecosystem more robust and future-proof.

As cloud infrastructures continue to evolve, the synergy of human expertise, sound frameworks like ATT&CK and D3FEND, and increasingly sophisticated automated detection capabilities will ensure that organizations remain well-prepared. By blending strategic planning with tactical execution, defenders can shift the balance of power from adversaries to security teams, maintaining the confidentiality, integrity, and availability of critical data and services. With each incremental improvement—be it through AI-driven automation, threat intelligence integrations, cross-cloud visualizations, or robust defensive mappings—organizations take a crucial step forward. The journey towards comprehensive, proactive, and adaptive runtime threat detection is ongoing, and by following the path illuminated by frameworks like MITRE ATT&CK, the security community can strive towards a future where cloud-driven innovation is not overshadowed by unmanaged risk.

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