# Resolving Intermittent 503 Errors in Istio: A Deep Dive into Connection Management for VictoriaMetrics

## I. Executive Summary

This report provides a comprehensive analysis and definitive solution for the intermittent 503 errors observed when the vmalert service attempts to remoteWrite data to the vminsert service within a Kubernetes environment managed by Istio.

**Problem Statement:** The vmalert pods are logging recurring 503 errors with the message "upstream connect error or disconnect/reset before headers. reset reason: connection termination". Critically, despite these errors, alert data is successfully persisted in vmstorage. This indicates the presence of a transient fault that is being overcome by an underlying retry mechanism, leading to system inefficiency and log noise rather than data loss.

**Root Cause Analysis:** The fundamental issue is a network race condition inherent to HTTP/1.1 keep-alive connections. This problem arises from a timeout mismatch between the server-side application (vminsert) and the client-side Envoy proxy (the istio-proxy sidecar in the vmalert pod). The vminsert server, configured with a shorter idle keep-alive timeout, preemptively closes the underlying TCP connection to conserve resources. Almost simultaneously, the Envoy proxy, which has a much longer default idle timeout, attempts to reuse this now-terminated connection for a new request, resulting in the observed connection termination error.[1]

**Primary Solution:** The definitive solution involves the strategic configuration of an Istio DestinationRule resource for the vminsert service. This rule will explicitly define connection pool settings for the client-side Envoy proxy. The key parameter, idleTimeout, will be set to a value that is demonstrably *less than* the vminsert server's keep-alive timeout. This proactive configuration ensures that the client-side proxy is the one to close idle connections, thereby completely eliminating the race condition.[1]

**Recommended Actions:** This report outlines a systematic, three-step process to

resolve the issue and harden the service-to-service communication path. The recommended actions are:

1. **Diagnose and Confirm:** Utilize kubectl and istioctl command-line tools to analyze proxy logs and inspect live Envoy configurations, confirming the timeout mismatch within the specific environment.
2. **Implement and Fortify:** Apply a robust DestinationRule to align connection timeouts and implement advanced resilience patterns, including connection pooling and outlier detection. Complement this with a VirtualService that defines an intelligent retry policy to handle other potential transient failures.
3. **Verify and Monitor:** Confirm the fix by re-inspecting the Envoy configuration and monitoring logs and metrics. Establish long-term monitoring of key Istio metrics to ensure ongoing system health and proactively detect future application-level issues.

By following the detailed guidance within this report, operators can transition their system from a resilient-but-inefficient state to a stable, optimized, and observable architecture.

## II. Deconstructing the "503 Connection Termination" Error

Understanding the precise meaning of the error message is the first step toward diagnosing and resolving the underlying issue. The message "503 upstream connect error or disconnect/reset before headers. reset reason: connection termination" is not a generic failure; it is a specific signal from the Istio Envoy proxy about a network-level event.

### Anatomy of the Error Message

Each component of the error provides a critical clue:

- **503 Service Unavailable**: This is the standard HTTP status code returned by the client-side Envoy proxy (within the vmalert pod) back to the vmalert application itself. It signifies that the proxy, acting on behalf of the application, was unable to establish a successful communication channel with the upstream service

(vminsert) and retrieve a response.[4]

- **upstream connect error or disconnect/reset before headers**: This is the detailed reason provided by Envoy. It pinpoints the failure to the TCP/IP layer of the connection between the vmalert proxy and the vminsert pod. The message indicates that the TCP connection was terminated *before* the proxy could even receive the HTTP response headers from the upstream server. This rules out application-level errors within vminsert (like a 500 Internal Server Error) and points directly to a connection lifecycle problem.[1]
- **reset reason: connection termination**: This confirms that the connection was actively closed by the upstream server (vminsert). In Envoy's detailed access logs, this event corresponds to the UC (Upstream Connection Termination) response flag, providing definitive proof that the server initiated the disconnect.[2]

**The HTTP Keep-Alive Race Condition Explained**

The root cause of this specific error sequence is a classic race condition related to HTTP keep-alive functionality, a performance optimization feature in HTTP/1.1 and later.

- **HTTP Keep-Alive:** To avoid the high cost of establishing a new TCP handshake for every single request, HTTP keep-alive allows clients and servers to send multiple requests and responses over a single, persistent TCP connection. This is the default and desired behavior for high-throughput services like vmalert's remoteWrite.[5]
- **The Timeout Mismatch:** To prevent resource exhaustion from countless idle connections, both the client (or its proxy) and the server maintain an "idle timeout" or "keep-alive timeout." If no data is exchanged over the connection for this specified duration, the component closes its end of the connection. The race condition is triggered when the server's idle timeout is shorter than the client-side proxy's idle timeout.[1]
- **The Race Sequence:**
  1. The vmalert Envoy proxy establishes a TCP connection to a vminsert pod and successfully sends one or more remoteWrite requests.
  2. The connection becomes idle. Both the Envoy proxy and the vminsert server start their respective idle timers.
  3. The vminsert server's timer, being shorter, expires first. To free up resources, the vminsert process instructs its operating system kernel to close the socket,

typically by sending a TCP FIN or RST packet to the vmalert proxy.

4. At nearly the same moment, vmalert generates a new alert to send. Its Envoy proxy, whose own longer idle timer has *not* yet expired, sees the connection as valid and reusable. It attempts to send the new HTTP request over this connection.
5. The request arrives at a socket that the vminsert server has just closed. This results in the "connection termination" error, which Envoy reports back to the vmalert application as a 503.[2]

The fact that data is ultimately written successfully is because the vmalert application or, more likely, an Istio retry policy, catches this transient 503 and immediately initiates a new connection attempt, which succeeds. This cycle of failure and retry is the source of the log spam and performance inefficiency.

**Default Timeout Discrepancies: The Inevitable Conflict**

This issue is exceptionally common in default Istio installations because of a fundamental philosophical difference in default timeout settings between Envoy and typical application servers. Envoy, as a generic proxy, aims to be non-intrusive and defaults to a very long idle timeout to maximize connection reuse. Application servers, conversely, often use short timeouts to protect themselves from resource exhaustion.

This inherent conflict is illustrated by comparing the default timeout of the Istio Envoy proxy with those of common application servers.

| Component | Default Keep-Alive/Idle Timeout | Source Snippet |
|---|---|---|
| **Istio Envoy Proxy (Client Side)** | **1 hour** | [2] |
| Node.js HTTP Server | 5 seconds | [2] |
| Nginx | 75 seconds | [2] |

| | | |
|---|---|---|
| Java (Tomcat) | 60 seconds | [2] |
| Apache HTTP Server | 15 seconds | [2] |

As the table clearly shows, virtually any standard application server deployed within an Istio mesh without specific tuning is susceptible to this race condition. The problem is not a bug in Istio or the application, but a predictable consequence of integrating two systems with different operational defaults. The solution, therefore, lies in harmonizing these configurations.

## III. Systematic Diagnosis in Your Environment

Before applying any configuration changes, it is crucial to perform a systematic diagnosis within the running environment to confirm that the keep-alive race condition is indeed the root cause. This process involves inspecting logs and live proxy configurations to gather concrete evidence.

#### Step 1: Analyze Envoy Proxy Logs for Confirmation

While the vmalert application container logs show the 503 error, the definitive proof resides in the logs of the istio-proxy sidecar container. This container's logs provide the low-level details of Envoy's interaction with the upstream vminsert service.

1. **Identify the vmalert Pod:** First, obtain the full name of a vmalert pod that is experiencing the issue. Replace <namespace> with the Kubernetes namespace where VictoriaMetrics is deployed.
   Bash
   `kubectl get pods -n <namespace> | grep vmalert`

2. **Inspect Proxy Logs:** Use the pod name to view the logs for the istio-proxy container.
   Bash
   `kubectl logs <vmalert-pod-name> -n <namespace> -c istio-proxy`

[6]

3. Look for the UC Response Flag: In the Envoy access log output, search for entries corresponding to failed requests made to the vminsert service. The key piece of evidence is the UC response flag in the log line. A typical log entry for this failure might look similar to this:
"POST /api/v1/write HTTP/1.1" 503 UC...
The UC flag is Envoy's specific code for "Upstream Connection Termination," which directly confirms that the vminsert server terminated the connection while Envoy was attempting to use it.2

**Step 2: Inspect the Live Envoy Configuration**

The next step is to verify the actual idleTimeout value being used by the vmalert pod's Envoy proxy for its connections to vminsert. This is accomplished using the istioctl proxy-config command, which directly queries the Istio control plane (istiod) and the live Envoy instance. This is a critical step to bridge the gap between the intended state (what is configured in YAML files) and the actual state (what is running in the data plane).

1. **Execute the Command:** Run the following command, replacing <vmalert-pod-name> and <namespace> with the correct values. The --fqdn flag filters the extensive output to only the configuration relevant to the vminsert service.
Bash
`istioctl proxy-config cluster <vmalert-pod-name> -n <namespace> --fqdn vminsert.<namespace>.svc.cluster.local -o json`

[8]

2. **Analyze the JSON Output:** In the resulting JSON output, search for the commonHttpProtocolOptions key.
    - Within this object, locate the idleTimeout field. In a default configuration, this field will likely be absent or explicitly set to "3600s", which confirms the 1-hour default that causes the race condition.[2]
    - Also, inspect the circuitBreakers and outlierDetection sections of the configuration. In an untuned environment, these will likely be absent or contain default values that set extremely high thresholds, effectively disabling them.[8] This confirms that no advanced resilience policies are currently in

place.

**Step 3: Determine the Server-Side (vminsert) Timeout**

The final piece of the diagnostic puzzle is to determine the keep-alive timeout of the vminsert server itself. This value is application-specific and must be found by inspecting the vminsert configuration.

1. **Check VictoriaMetrics Documentation:** The most reliable method is to consult the official VictoriaMetrics documentation for command-line flags or configuration file parameters that control HTTP server behavior. Look for flags such as -http.keepAlive, -http.idleTimeout, or similar.
2. **Inspect the vminsert Deployment:** Examine the Kubernetes Deployment or StatefulSet manifest for the vminsert component. Look at the spec.template.spec.containers.args or spec.template.spec.containers.command fields to see if any relevant timeout flags are being passed at runtime.
   Bash
   ```
   kubectl get deployment <vminsert-deployment-name> -n <namespace> -o yaml
   ```
3. **Assume a Conservative Default:** If the exact value cannot be determined, it is safe to proceed by assuming a common industry default, such as 60 or 75 seconds.[2] The proposed solution is robust as long as the Envoy proxy's idle timeout is configured to be definitively lower than this assumed server-side timeout.

With this three-step diagnosis complete, there will be clear evidence of the timeout mismatch, providing the necessary justification for the configuration changes outlined in the following sections.

## IV. The Primary Solution: Aligning Timeouts with a DestinationRule

The definitive solution to the keep-alive race condition is to use an Istio DestinationRule. This resource allows for fine-grained control over the behavior of

client-side Envoy proxies when they connect to a specific destination service.

While a VirtualService directs traffic by answering the question *where* should a request go, a DestinationRule configures the connection itself, answering the question *how* should the client connect.[5] It is the correct and intended mechanism for managing client-side policies such as connection pooling, load balancing strategies, outlier detection, and, most importantly for this issue, connection timeouts.[9]

**Prerequisite: Verifying Service Port Naming**

Before creating the DestinationRule, a critical and often overlooked prerequisite must be verified. The idleTimeout setting is part of the **HTTP** connection pool configuration. For this setting to have any effect, Istio must correctly identify the traffic from vmalert to vminsert as HTTP traffic.

Istio's automatic protocol detection can be unreliable, especially for services that use non-standard ports. If the protocol is not detected as HTTP, Istio will treat the traffic as opaque TCP, and the entire http section of the connectionPool configuration in the DestinationRule will be silently ignored, rendering the fix ineffective.[10]

To prevent this, the protocol must be explicitly declared in the vminsert Kubernetes Service definition.

1. **Inspect the vminsert Service:** Retrieve the YAML for the vminsert service.
   Bash
   kubectl get service vminsert -n <namespace> -o yaml

2. Ensure Correct Port Naming: Locate the port definition used for remoteWrite traffic (e.g., port 8480). The name of this port must follow the convention <protocol>[-<suffix>]. For this traffic, a correct name would be http-remotewrite or simply http.
   Incorrect:
   YAML
   ports:
   - port: 8480
     targetPort: 8480
     name: remotewrite # Istio will likely treat this as TCP

**Correct:**

```yaml
ports:
- port: 8480
  targetPort: 8480
  name: http-remotewrite # Explicitly tells Istio this is an HTTP port
```

10

Ensuring the port is correctly named is a mandatory first step for the DestinationRule to function as intended.

### Configuring the idleTimeout

The core principle of the fix is to reverse the timeout relationship, ensuring the client-side proxy is more proactive about closing idle connections than the server.

**Rule:** Client-side Proxy Idle Timeout **<** Server-side Application Keep-Alive Timeout.[1]

This is achieved by configuring the trafficPolicy.connectionPool.http.idleTimeout field in the DestinationRule for vminsert.[3]

For example, if the vminsert server's keep-alive timeout was determined or assumed to be 60 seconds, a safe and effective value for the Envoy proxy's idleTimeout would be 55 seconds. This small buffer ensures that under idle conditions, the Envoy proxy will always be the one to initiate the connection closure, preventing the server from doing so unexpectedly while the proxy is attempting to send a new request.

### Implementation for vminsert

The following DestinationRule provides the initial fix. It should be applied in the same namespace where the VictoriaMetrics components are deployed.

YAML

```yaml
apiVersion: networking.istio.io/v1
kind: DestinationRule
metadata:
  # A descriptive name for the policy
  name: vminsert-timeout-fix
  # Apply in the namespace where VictoriaMetrics is deployed
  namespace: <vm-namespace>
spec:
  # Best Practice: Always use the Fully Qualified Domain Name (FQDN) of the service.
  # This prevents ambiguity and ensures the rule is correctly applied, regardless of
  # the namespace it is defined in. [9]
  host: vminsert.<vm-namespace>.svc.cluster.local
  trafficPolicy:
    connectionPool:
      http:
        # This is the primary fix for the 503 connection termination error.
        # This value MUST be set lower than the vminsert server's own keep-alive timeout.
        # Assuming the vminsert timeout is >= 60 seconds, 55s is a safe value.
        # This forces the client-side Envoy proxy to close idle connections before the server does.
        idleTimeout: 55s
```

Applying this single resource will resolve the 503 errors. However, to build a truly production-grade system, this fix should be augmented with additional resilience policies.

## V. Fortifying the Connection: Advanced Resilience Policies

Resolving the idleTimeout mismatch eliminates the primary source of errors. The next step is to elevate this simple fix into a comprehensive, production-ready resilience strategy. This involves configuring policies to handle other potential failures, moving the system towards a self-healing and robust state.

### Configuring Intelligent Retries in the VirtualService

The fact that data was being saved despite the 503 errors strongly implies a retry mechanism was already at work. By explicitly defining a retry policy in a VirtualService, control over this behavior is formalized, making it more predictable and robust. While the primary cause of retries is being fixed, this policy will protect against other transient network issues, such as momentary packet loss or temporary unavailability during a pod restart.[4]

Retries are configured in a VirtualService that routes traffic to the vminsert destination.

**Key Parameters for Retry Policy:**

- attempts: The maximum number of times to retry a failed request. A value of 3 is a common and reasonable starting point.
- perTryTimeout: A timeout for each individual retry attempt. This is crucial to prevent a single slow or hung request from blocking the client application. A short timeout, such as 2s, ensures that retries fail fast.
- retryOn: A comma-separated list of conditions that will trigger a retry. For the observed "connection termination" issue, the most relevant conditions are connect-failure, refused-stream, and gateway-error (which includes 503s).[4]

**Idempotency Consideration:** It is critical to only enable retries for operations that are idempotent. An idempotent operation can be performed multiple times without changing the result beyond the initial application. HTTP methods like GET, PUT, and DELETE are typically idempotent. POST is generally not. In this specific case, VictoriaMetrics' remoteWrite endpoint is designed to be idempotent, making it safe to retry.

### Implementing Outlier Detection in the DestinationRule

The timeout fix and retry policy address transient, network-level problems. OutlierDetection addresses a different, more severe class of failure: an unhealthy service instance. If one of the vminsert pods becomes "sick"—for example, it is stuck in a crash loop, experiencing high garbage collection pauses, or consistently failing

requests—it can degrade the performance of the entire service.

OutlierDetection is Istio's implementation of a passive circuit breaker.[12] It allows the client-side Envoy proxy to monitor the health of each individual upstream pod. If a pod consistently returns errors, Envoy will temporarily "eject" it from the load-balancing pool. This routes traffic away from the unhealthy instance, giving it time to recover without affecting new requests. This is a cornerstone of building a self-healing architecture.[13]

This policy is configured within the same DestinationRule used for the timeout fix, under the trafficPolicy section.

**Key Parameters for Outlier Detection:**

- consecutiveGatewayErrors: The number of consecutive gateway errors (502, 503, 504) that must occur before a host is ejected. A value of 5 is a sensible default, preventing ejections due to brief glitches.[9]
- interval: The time interval between ejection analysis scans. A value of 10s means Envoy checks the health status of hosts every 10 seconds.
- baseEjectionTime: The minimum duration for which a host will be ejected. For example, 30s. The actual ejection time increases exponentially with subsequent, consecutive ejections, giving persistently failing pods more time to recover.
- maxEjectionPercent: A critical safety valve. This sets the maximum percentage of hosts in the load-balancing pool that can be ejected at any given time. A value of 50 prevents a cascading failure where all upstream pods are ejected if there is a widespread problem.[13]

By combining the idleTimeout fix with intelligent retries and outlier detection, the communication path becomes resilient to both transient network faults and persistent instance-level failures.

## VI. A Production-Grade, Consolidated Configuration

This section consolidates the principles discussed into a set of complete, annotated, and production-ready Istio configurations. These YAML manifests provide a robust policy for the vmalert-to-vminsert communication path, incorporating the primary timeout fix along with advanced resilience patterns.

**The Unified DestinationRule**

The following DestinationRule is the cornerstone of the solution. It combines the idleTimeout setting with best-practice connection pooling limits and a comprehensive outlierDetection policy. The table below summarizes the key parameters and their functions, providing a quick reference for understanding the configuration.

| Parameter | Location | Function | Recommended Value | Source Snippet |
|---|---|---|---|---|
| host | spec | Specifies the target service. MUST be FQDN to avoid ambiguity. | vminsert.<ns>.svc.cluster.local | 9 |
| http.idleTimeout | trafficPolicy.connectionPool | **The core fix.** Prevents the keep-alive race condition by ensuring the client-side proxy closes idle connections first. | 55s (or < server timeout) | 2 |
| tcp.maxConnections | trafficPolicy.connectionPool | A circuit breaker that limits the total number of TCP connections to the upstream service, preventing it from being overwhelmed. | 100 | 9 |
| http.http1MaxPendingRequests | trafficPolicy.connectionPool | Limits the number of | 1024 | 9 |

| | | | | |
|---|---|---|---|---|
| | | HTTP/1.1 requests that can be queued by Envoy while waiting for a connection, preventing client-side resource exhaustion. | | |
| outlierDetection.consecutiveGatewayErrors | trafficPolicy | Ejects a pod from the load balancing pool after it returns N consecutive 502, 503, or 504 errors. | 5 | [9] |
| outlierDetection.interval | trafficPolicy | The frequency at which Envoy scans hosts for potential ejection. | 10s | [9] |
| outlierDetection.baseEjectionTime | trafficPolicy | The minimum duration an unhealthy pod is removed from the pool, giving it time to recover. | 30s | [9] |
| outlierDetection.maxEjectionPercent | trafficPolicy | A safety valve that prevents a cascading failure by limiting the maximum percentage of pods that can be ejected at once. | 50 | [9] |

### Final DestinationRule YAML

YAML

```yaml
apiVersion: networking.istio.io/v1
kind: DestinationRule
metadata:
  name: vminsert-production-policy
  namespace: <vm-namespace> # Replace with the namespace of your VictoriaMetrics deployment
spec:
  host: vminsert.<vm-namespace>.svc.cluster.local
  trafficPolicy:
    # Connection pool settings to manage load, timeouts, and prevent resource exhaustion.
    connectionPool:
      tcp:
        # Limits the total number of concurrent TCP connections from each vmalert proxy to the vminsert service.
        maxConnections: 100
      http:
        # Sets the maximum number of pending HTTP/1.1 requests that will be queued.
        http1MaxPendingRequests: 1024
        # THE FIX: This idle timeout must be less than the vminsert server's keep-alive timeout.
        idleTimeout: 55s

    # Outlier detection policy to automatically detect and eject unhealthy vminsert pods from the load balancing pool.
    outlierDetection:
      # Eject a pod after it returns 5 consecutive 502, 503, or 504 errors.
      consecutiveGatewayErrors: 5
      # Run the outlier detection analysis every 10 seconds.
      interval: 10s
      # Ejected pods will be removed for a minimum of 30 seconds.
      baseEjectionTime: 30s
      # Do not eject more than 50% of the pods in the pool, as a safety measure.
```

```
    maxEjectionPercent: 50
```

### The Paired VirtualService with Retries

To complement the DestinationRule, the following VirtualService establishes an explicit and intelligent retry policy. If a DestinationRule for the same host already exists, this retries block can be added to it. If not, this VirtualService can be created.

YAML

```yaml
apiVersion: networking.istio.io/v1
kind: VirtualService
metadata:
  name: vminsert-routing-policy
  namespace: <vm-namespace> # Replace with the namespace of your VictoriaMetrics deployment
spec:
  hosts:
    - vminsert.<vm-namespace>.svc.cluster.local
  http:
    - route:
        - destination:
            host: vminsert.<vm-namespace>.svc.cluster.local
      # Retry policy to gracefully handle any remaining transient network failures.
      retries:
        # Attempt a failed request up to 3 times.
        attempts: 3
        # Set a 2-second timeout for each retry attempt to fail fast.
        perTryTimeout: 2s
        # Only retry on specific, recoverable network-level errors.
        retryOn: connect-failure,refused-stream,gateway-error
```

Applying these two resources provides a multi-layered defense against the observed errors and other potential failures, creating a more stable and resilient system.

## VII. Verification and Long-Term Monitoring

After applying the new configurations, it is essential to verify that the changes have taken effect and to establish monitoring to ensure long-term system health.

### Confirming the Fix

Follow these steps to confirm that the solution is working as intended:

1. **Apply the Configurations:** Use kubectl apply to create or update the DestinationRule and VirtualService in the appropriate namespace.
   Bash
   ```
   kubectl apply -f vminsert-destination-rule.yaml -n <vm-namespace>
   kubectl apply -f vminsert-virtual-service.yaml -n <vm-namespace>
   ```

2. **Verify Envoy Configuration Propagation:** The most important verification step is to re-run the istioctl proxy-config command from the diagnosis phase. This confirms that the Istio control plane has pushed the new configuration to the vmalert pod's Envoy proxy.
   Bash
   ```
   istioctl proxy-config cluster <vmalert-pod-name> -n <namespace> --fqdn vminsert.<namespace>.svc.cluster.local -o json
   ```

   In the JSON output, you should now see the new values reflected. Specifically, the idleTimeout should be "55s", and the outlierDetection object should be populated with the configured parameters.[8] If the old values are still present, wait a few moments and try again, as propagation can take a few seconds.
3. **Monitor Application Logs:** Tail the logs of the vmalert application container. The 503 upstream connect error... connection termination messages should cease to appear.
   Bash
   ```
   kubectl logs -f <vmalert-pod-name> -n <namespace> -c vmalert
   ```

4. **Monitor Prometheus Metrics:** Observe the metrics related to vmalert's remoteWrite operations within your Prometheus or VictoriaMetrics monitoring system. You should see a significant and sustained drop in the rate of 5xx errors for these requests.

### Monitoring Key Istio Metrics for Long-Term Health

To maintain operational awareness and proactively detect future issues, it is highly recommended to monitor the following Istio-generated Prometheus metrics related to this traffic flow:

- **Request Errors:** This metric should drop to zero for the specific error type.
  - **Metric:** istio_requests_total
  - **Query:** sum(rate(istio_requests_total{destination_service="vminsert.<vm-namespace>.svc.cluster.local", response_code="503", response_flags="UC"}[5m]))
  - **Expected Result:** The value should be 0. Any non-zero value indicates the race condition is still occurring.
- **Outlier Detection Ejections:** This metric is a powerful signal for application health. It tracks when the outlierDetection policy is actively ejecting vminsert pods.
  - **Metric:** istio_outlier_detection_ejections_total
  - **Query:** sum(rate(istio_outlier_detection_ejections_total{destination_service="vminsert.<vm-namespace>.svc.cluster.local"}[5m]))
  - **Interpretation:** A non-zero, increasing value for this counter is a critical alert. It means that one or more vminsert pods are unhealthy and are being circuit-broken by Istio. While the system remains resilient because traffic is being routed away from the faulty pod, this metric serves as a proactive signal for an operator to investigate the health of the vminsert pods themselves. Investigation could involve checking pod logs (kubectl logs), events (kubectl describe pod), and resource utilization (kubectl top pod) to find the root cause of the pod's sickness.[15]

By implementing these verification and monitoring practices, operators can not only solve the immediate problem but also gain deeper visibility into the health and performance of their service mesh interactions, ensuring a stable and reliable

observability platform.

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