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Oracle Audit Vault and Database Firewall

Database Activity Monitoring for the Enterprise

June, 2023, Version 20.9

Purpose statement

This technical report provides an overview of Oracle Audit Vault and Database Firewall, including a discussion of features, options, and use cases. It is intended to help you evaluate options for reducing security risk and improving regulatory compliance for your databases – including Oracle Database, Oracle MySQL, Microsoft SQL Server, PostgreSQL, IBM Db2, and SAP Sybase with easy extension to support most other enterprise database platforms.

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Introduction

Oracle Databases contain more than half of the world's relational data. Much of that data is sensitive and has monetary value. That is why databases, especially Oracle Databases, are an attractive target for data thieves.

Database Activity Monitoring (DAM) is a database security technology that collects information from native database audit and network-based data capture to monitor and record database activity for analysis and reporting. Database Activity Monitoring is critical to securing data in a relational database, providing visibility into potentially malicious activity when preventive controls fail.

Combining audit data with network-based activity monitoring and blocking is the best way to gain a complete picture of database activity. Network monitoring alone cannot catch all suspicious behavior – a solution focused solely on network monitoring won't understand database synonyms, function-based views, or stored-procedure activity. Conversely, it is impractical to audit every operation in a database, so a solution focused only on auditing can't see the bigger picture of all database activity needed to identify anomalies and help identify suspicious activity. The combination of auditing and network-based monitoring solves those issues and supports both security and regulatory compliance goals.

As the product's name implies, Audit Vault and Database Firewall contains a database firewall. Database firewalls monitor and evaluate incoming SQL commands at the network level, identifying and alerting on anomalies or out-of-policy operations. When appropriate, a database firewall can be used to block out-of-policy SQL from reaching the database at all.

Activity monitoring is essential, but organizations are also worried about the security posture of their databases. Were best practices followed best when configuring the databases? Are databases in compliance with security standards? What else should be considered to strengthen the Oracle Database further? Database security posture management (DSPM) helps answer those questions, combining the ability to assess database configuration and security settings with sensitive data discovery to provide an integrated picture of a database's risk and security posture.

Audit Vault and Database Firewall was first introduced in 2012, merging two existing products – Oracle Audit Vault and Oracle Database Firewall – into a single unified offering that, for the first time, took advantage of the synergy between native database audit and network-based activity monitoring to provide a comprehensive view of database activity. Audit Vault and Database Firewall 20.9 expands the product's capabilities from database activity monitoring (DAM) to database security posture management (DSPM)

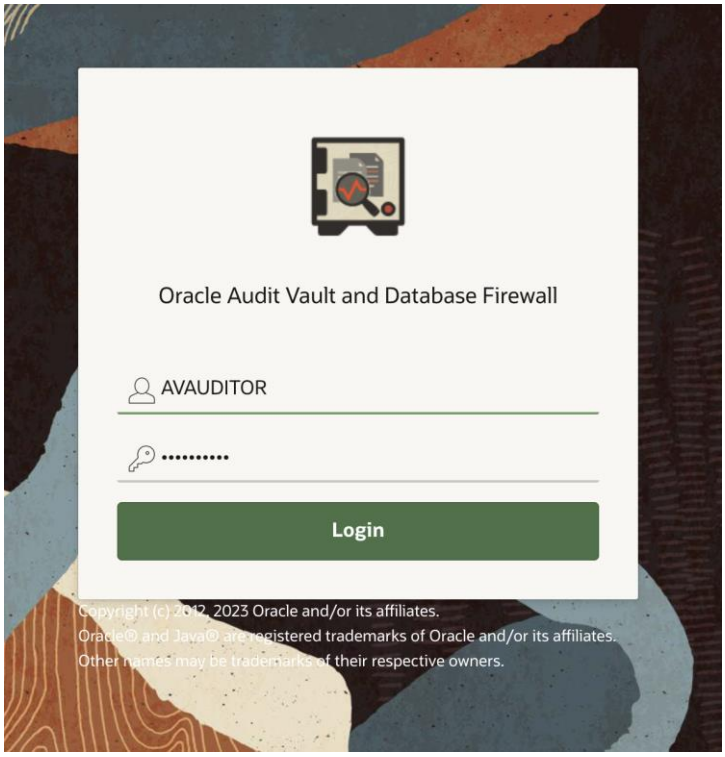

Figure 1 – Oracle Audit Vault and Database Firewall Login

Oracle Audit Vault and Database Firewall Overview

Oracle Audit Vault and Database Firewall (AVDF) expands beyond database activity monitoring to manage your Oracle Database's security posture, enhancing AVDF's best-in-class activity monitoring capabilities with visibility into security configuration, user entitlements, stored procedures, and how much and what types of data are in the database.

AVDF aggregates user audit data from Oracle and non-Oracle databases, operating systems, and directories, whether on the cloud or on-premises, into a single repository for analysis, alerting, and reporting. AVDF is an enterprise-level audit platform with scalability, security, and automation. AVDF also monitors SQL statements submitted to the database over the network and can examine, allow, log, and even block unauthorized SQL statements. The Database Firewall offers network-based SQL inspection with easy rules to identify anomalies and block unauthorized SQL or SQL injection attacks.

Through powerful reporting and alerting, AVDF supports compliance audits and incident investigations and provides a modern, scalable platform for a full 360-degree view. AVDF includes extensive reporting capabilities using a simple

filter-based interactive reporting interface that allows quick drill-down to relevant information. With AVDF, a single system can monitor activity across thousands of databases, providing a single console from which to report and analyze security events throughout the database estate – including supporting infrastructure.

Oracle Audit Vault and Database Firewall supports database activity monitoring for common enterprise-class databases. Out-of-box audit collection support includes Oracle Database, Oracle MySQL, Microsoft SQL Server, SAP Sybase, IBM Db2 LUW, and PostgreSQL. Support for most other databases and applications is possible using the included custom connector framework, which collects data via JDBC or RESTful API. The custom collection is also possible from systems that write audit data to XML or JSON files. A Java-based software development kit (SDK) is included to accommodate those rare targets that cannot be accessed using any custom connector framework options. Database Security Posture Management is currently only provided for Oracle Database.

AVDF's fleet-level view facilitates insight into Oracle Database configuration, enabling the detection of issues across the database estate. Armed with this information, administrators can quickly mitigate issues to reduce risk and control data exposure.

Highlights for Oracle Audit Vault and Database Firewall release 20

AVDF 20 is the culmination of over a decade of continuous development. AVDF 20 offers a simplified user interface, extended coverage for new databases, updates to the underlying infrastructure, a scalable, proven architecture for collecting before and after values, and more.

User Interface

AVDF's user interface engine gives you a modern, responsive, intuitive look and feel. The UI is simplified and optimized for common workflows and easier navigation. The audit vault server and the database firewall are managed from the same console - centralizing the administrative activities and reducing the number of consoles that need monitoring.

Coverage for Most Database Types

AVDF 20 supports audit and network collection for Oracle Database, Oracle MySQL, Microsoft SQL Server, SAP Sybase, and IBM Db2 LUW. Audit collection is also supported for PostgreSQL and MongoDB databases. The custom collector framework allowed you to add audit collection for other databases that produced audit data in XML, JSON, or CSV format or write their audit trails to a database table that can be accessed via JDBC.

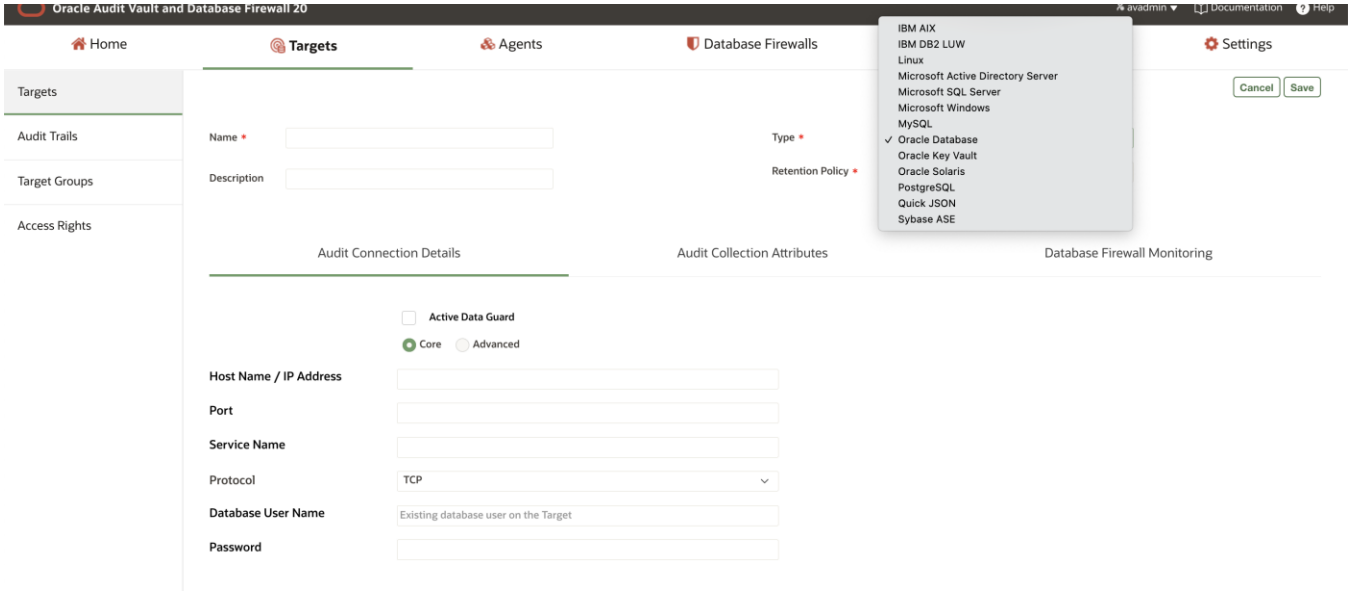

Figure 2 – Registering a New Target

Database Security Posture Management

Database security posture management (DSPM) provides a fleet-wide simplified and centralized view of security configuration assessments for Oracle Database, along with the security findings and associated risks. Summarized risk findings help prioritize and guide immediate action on potential risks associated with the Oracle Database fleet. Users can start by understanding the high and medium risks and then look at the advisory and evaluate categories to further harden the security posture. Expand on the risk of interest and continue to further analysis on the Assessment Report page with powerful interactive reporting provided by AVDF.

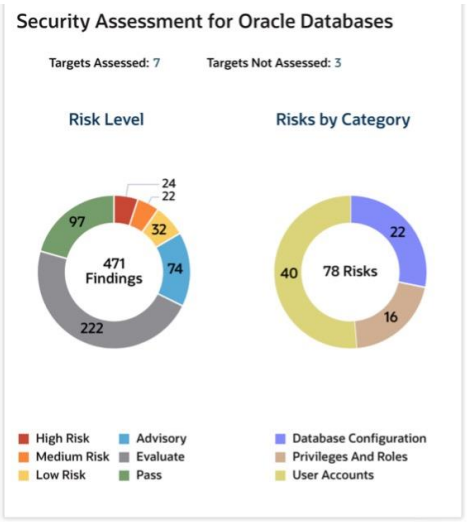

Figure 3 – Security Assessment for Oracle Databases

Before and After Value Collection

Before and after value collection is just what it sounds like. If a data value is changed, AVDF records the old value (*before* the change) and the new value (*after* the change), along with who and when it was changed. Before and after value collection is extensively used in the healthcare and financial services industry and many other regulated industries. With before and after value collection, auditors can track the lifecycle of individual data attributes throughout changes – an essential component of many data governance mandates.

AVDF 20 uses Oracle GoldenGate (restricted use of GoldenGate is included with AVDF – see the AVDF License Information guide for details) for before and after value collection. Using Golden Gate brings a lot of advantages, including improved throughput, easier administration, support for multi-tenant databases, and support for Oracle Database 19c. With AVDF 20.9, we extended the ability to capture before and after values to Microsoft SQL Server. This new functionality helps organizations improve their compliance reporting and enables them to monitor critical data elements throughout the data lifecycle.

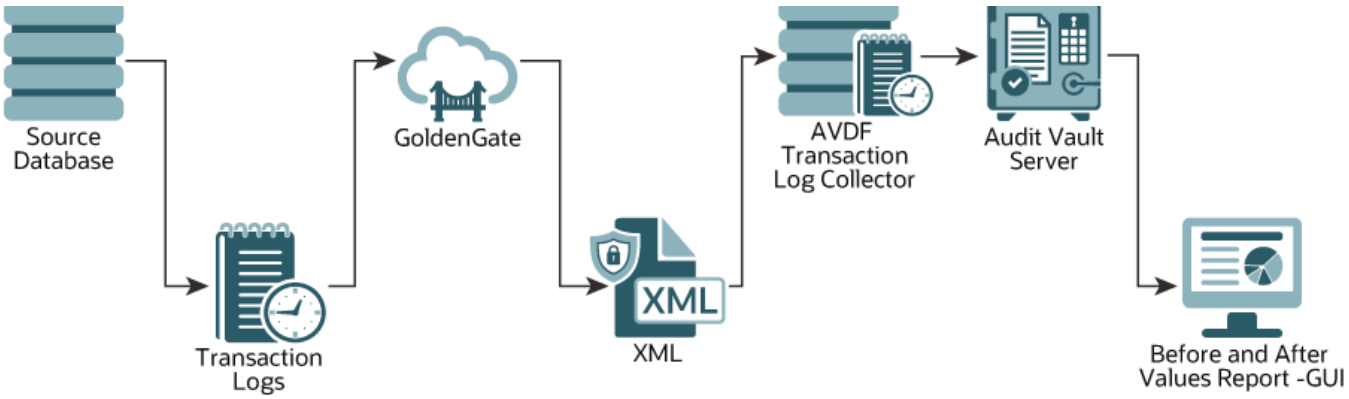

Figure 4 - Transaction Audit Trail Data Flow

Improved Operations Experience

AVDF 20 supports automated archiving of collected data, integration of AVDF users with Microsoft Active Directory or OpenLDAP, multipath fiber channel, network interface card bonding, and AVDF port customization. AVDF administrators and systems integrators will find the new version easier to work with and a better fit for modern data centers and cloud deployments.

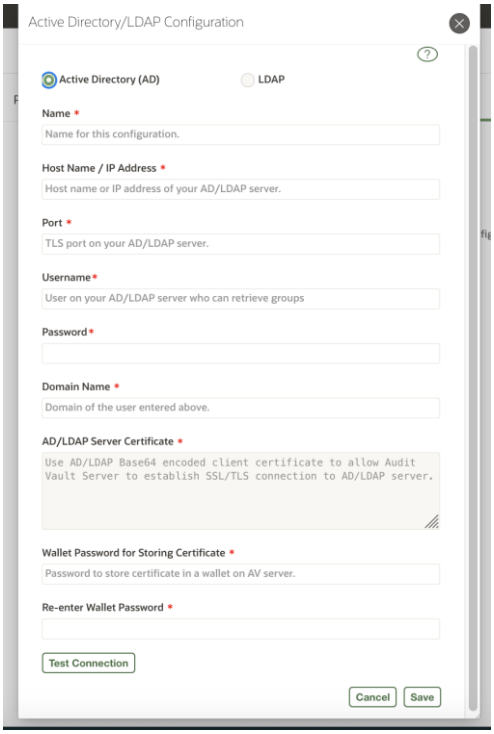

Figure 5 - Active Directory Integration

Reports and Alerts

Reports and alerts are the primary output of a DAM system like Oracle Audit Vault and Database Firewall. Information collected by the system is presented in the form of reports and, when appropriate, alerts.

Alerts notify interested parties when conditions that rate immediate attention are detected. Examples of common alerts would be multiple failed logins in a short time or unauthorized attempts to access sensitive data. In AVDF, alerts can be triggered based upon individual events like someone attempting to access a highly sensitive date, or event trends like more than ten failed logins from a single IP address over the course of 1 minute.

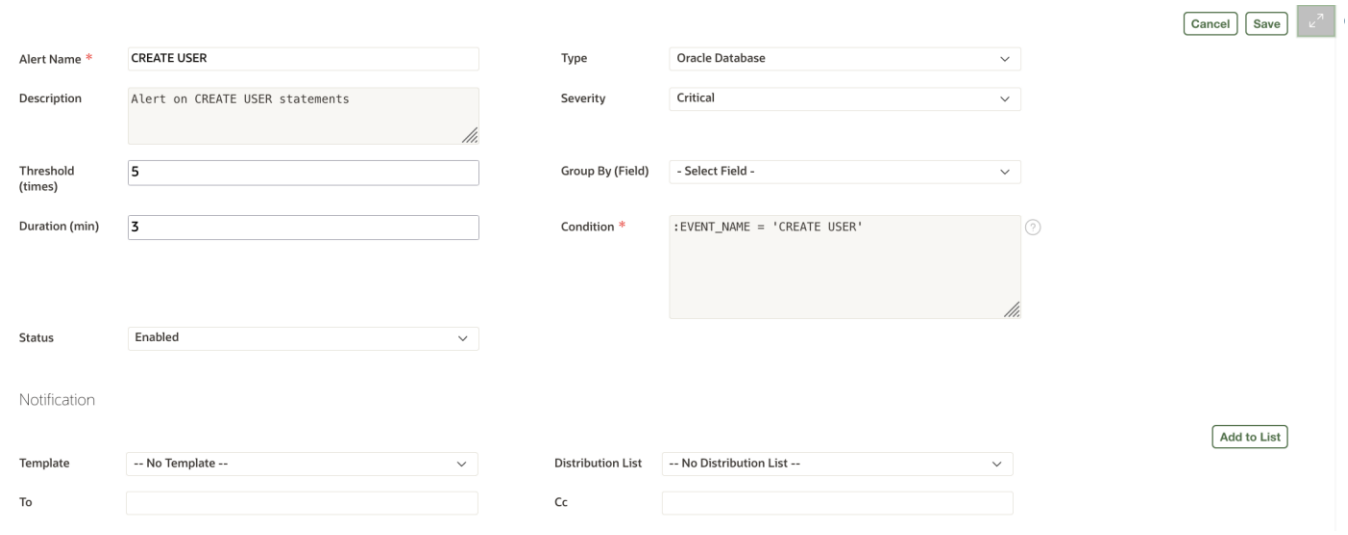

Figure 6 – Creating an Alert Policy

Reports may be formal reports for record or regulatory purposes or ad-hoc interactive reports that support investigations. Auditors may access reports through the Audit Vault and Database Firewall console, or reports may be scheduled for automatic generation in a spreadsheet or document format and distribution via email. If desired, an attestation that a report has been reviewed, along with any notes from the reviewer, can be tracked within AVDF.

AVDF comes pre-configured with dozens of reports ready to run – from compliance reports supporting regulations like HIPAA, PCI, and GDPR to standard security requirements like failed login reports, SUDO activity reports, and DML. Custom reports can be easily created and preserved for later use.

The audit Insights dashboard offers a bird's eye view and provides immediate insight into the top user activities across one or multiple databases.

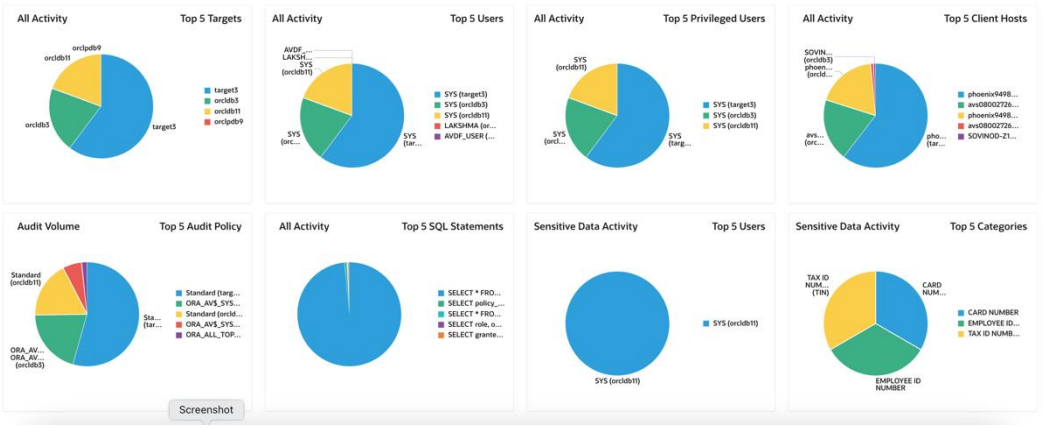

Figure 7 – Audit Insights Dashboard

In addition to AVDF's extensive reporting capabilities, AVDF also allows the use of external reporting or analytics tools that are compatible with the Oracle Database, and we include a limited-use license for Oracle Business Intelligence Publisher with AVDF.

Oracle Audit Vault and Database Firewall Components

Oracle Audit Vault and Database Firewall (AVDF) provides a comprehensive and flexible solution for monitoring and protecting database systems. AVDF is composed of four primary components:

- Audit Vault Server
- Audit Vault Agent
- Database Firewall
- Host Monitor

Audit Vault Server

The audit vault server is a mandatory component of AVDF. Every AVDF installation will have at least one audit vault server. This server comprises a hardened Oracle Linux operating system, Oracle Database, which serves as the audit repository, and the Audit Vault and Database Firewall application which provides the interface for the AVDF console and the AVCLI command-line interface.

Oracle Audit Vault and Database Firewall consolidates data from *audit targets,* including Oracle and non-Oracle databases, operating systems, directories, file systems, and application-specific audit data. This data is collected from audit targets and loaded into the audit repository, an Oracle Database, which resides on the audit vault server.

The audit repository database is encrypted (using Oracle Transparent Data Encryption) and protected with Oracle Database Vault.

Audit Vault Agent

An audit vault agent is used to retrieve audit data from audit targets and securely forward that data to the Audit Vault server. A single audit vault agent can collect data from multiple targets and audit trails. The audit vault agent is lightweight, consuming little in the way of CPU, memory, or disk space. Communications between the audit vault agent and the audit vault server use TLS 1.2.

Audit Vault and Database Firewall 20.9 introduces an “Agentless” collection of unified audit data in Oracle Databases. With the agentless collection, you use the agentless collection service that comes with the Audit Vault Server instead of deploying the Audit Vault Agent on the target host machines. The agentless collection service is automatically installed when you install the Audit Vault Server or when you update Oracle AVDF to release 20.9 or later.

Database Firewall

The database firewall monitors network activity sent to the database and examines SQL statements before they reach the database. A database firewall policy governs what is done with those SQL statements – the database firewall may pass them on to the database with no further action or forward information about them to the audit vault server for entry into the audit repository. If the database firewall is configured in line with that traffic (acting as a database proxy server) then the firewall can also block SQL statements from ever reaching the target database or substitute a replacement SQL command for the blocked statement. The database firewall uses a multi-stage policy to determine what to do with an SQL statement.

In the first stage, the policies examine the originating connection’s IP address, operating system username, program being used to connect to the database, and the database account being used for the connection. The firewall can be configured to allow connections that meet conditions based on these factors, log them for later examination, or (if in-line) block them.

The next stage is based on the SQL statement’s structure, with pass/log/block actions based on the statement’s syntax. This type of policy is an excellent way to block or alert SQL Injection attacks.

The third stage is based on the table/views being accessed and the operations being performed (e.g., insert/update/delete).

The fourth stage is the anomaly stage – any SQL statement not handled in any of the three previous stages is handled by this policy. You might think of it as the “else” phrase in a case statement. Any SQL statement that reaches the fourth stage will be passed/logged/blocked depending on the settings in this portion of the firewall policy.

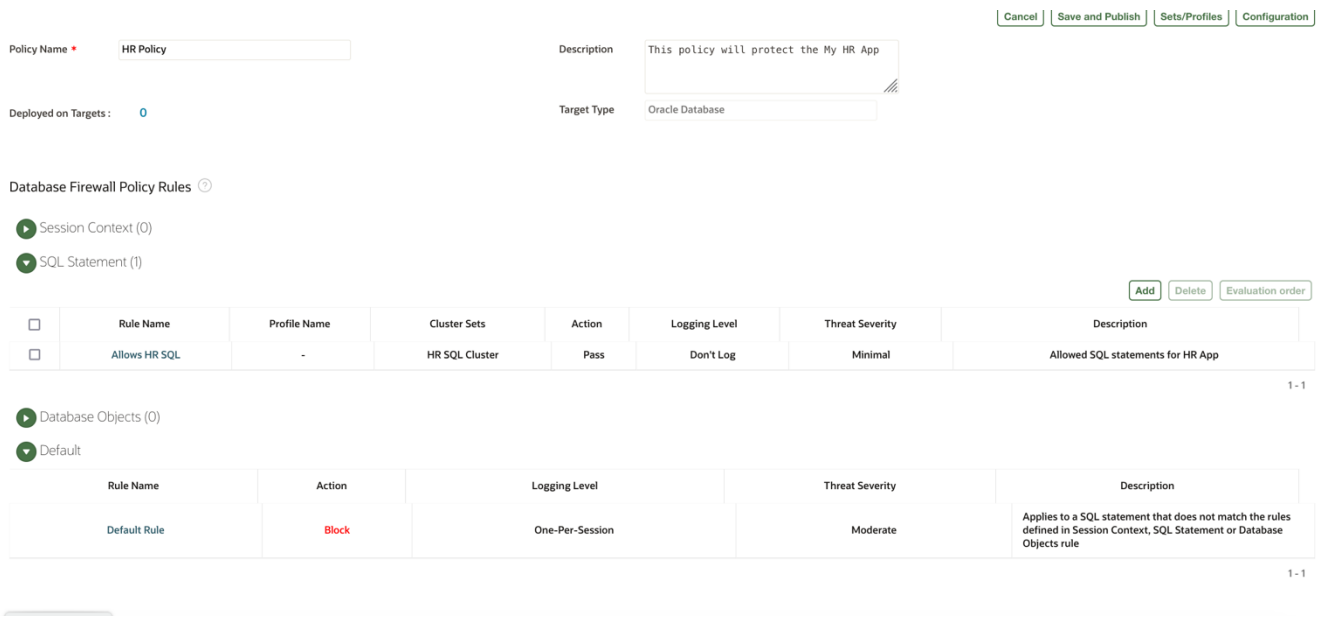

Figure 8 - Database Firewall Policies

Host Monitor

Host monitors are remote sensors for the database firewall. A host monitor is installed on the same server as the audit target and monitors incoming network traffic for the database. Host monitors can only be used to monitor traffic, so blocking actions is not possible. Anything captured by the host monitor is forwarded to the database firewall for analysis according to the target's policy on that firewall, with logged SQL statements forwarded to the audit vault server for insertion into the audit repository.

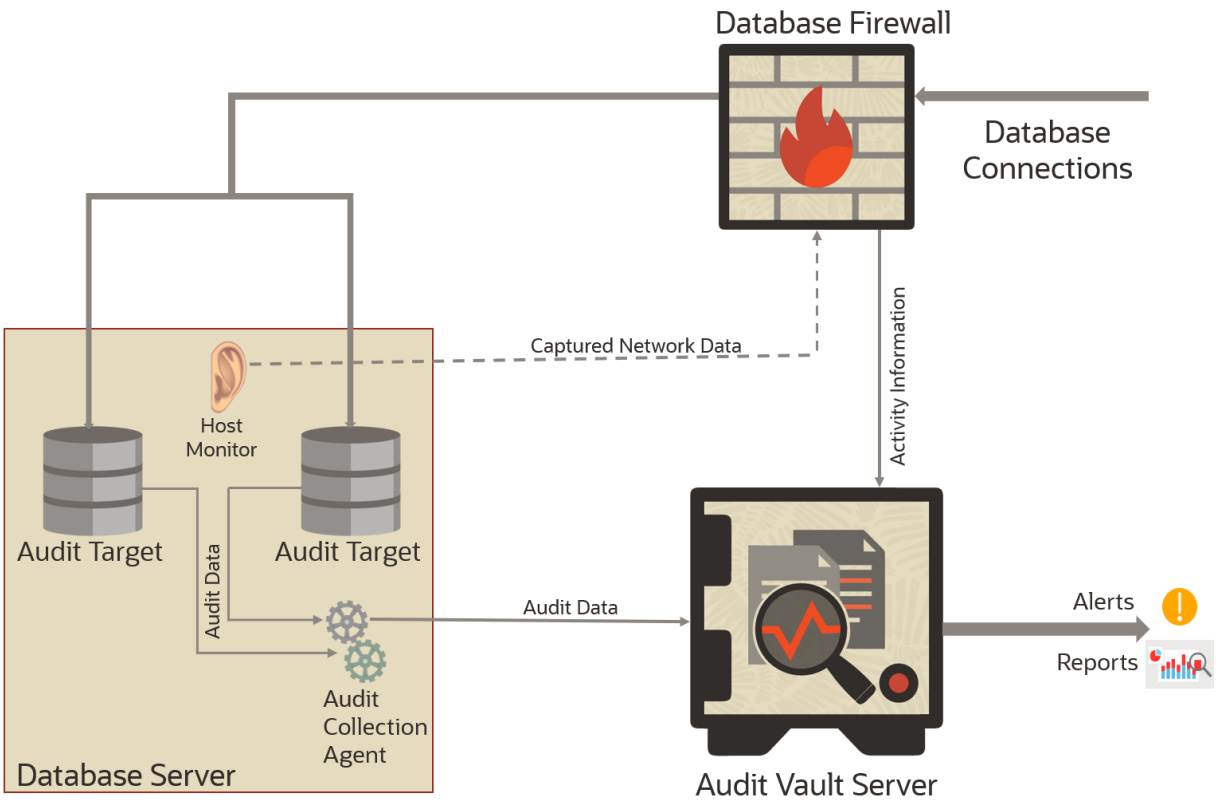

Figure 9 - Simplified Architecture Diagram

Scalability and Security

Audit data is an important record of business activity, and it must be protected against modification to ensure the integrity of reports and investigations. Oracle Audit Vault and Database Firewall stores audit data in a secure repository built using Oracle's industry-leading database technology. To prevent unauthorized access or tampering, audit, and event data is encrypted at every stage, in-transit, and at-rest. Timely transfer of audit data from source systems to the audit vault server is critical to close the window on intruders who may attempt to modify audit data and cover their tracks

Oracle Audit Vault and Database Firewall supports two broad categories of users: auditors and administrators. Auditors configure auditing and monitoring policies and define, generate, and access audit reports and alerts. Administrators configure basic network and host settings for the secured targets, start and stop audit vault agents and database firewalls, and configure and monitor audit vault server operation. Administrators do not have access to audit information. Within the two role categories, further separation of duties can be defined. A subset of databases can be assigned to individual auditors and administrators, ensuring that a single repository can be deployed to support an entire enterprise spanning multiple organizations, subsidiaries, or geographic regions.

Fine-grained authorizations are particularly important when information may span multiple countries with different privacy regulations and data protection requirements.

The repository is built on an embedded Oracle Enterprise Edition database that includes numerous Oracle technologies, including compression, in-memory optimization, partitioning, encryption, and privileged user controls. The use of compression is particularly important for optimized storage of consolidated data. The combination of these technologies and Oracle Database results in a repository with massive scalability, high availability, and security.

A single Oracle Audit Vault and Database Firewall can scale to support thousands of databases. The only limit is the capability of the server hardware where the Audit Vault Server is installed.

Flexible Deployment Options

Oracle Audit Vault and Database Firewall is flexible enough to meet almost any deployment scenario.

Audit Vault Agents

Audit vault agents are normally installed on the same server as the audit target, but in some cases, can be used to retrieve audit data from a remote audit target (for example, databases where the audit volume is low or it is not practical to install an agent on the database server). As mentioned earlier, Oracle Database targets may take advantage of agentless collection (new in AVDF 20.9).

Database Firewall

Database firewall can monitor network traffic to the database in several ways.

The database firewall can be placed in line with the network traffic, acting as a proxy server between the database and database clients. This is a common deployment mode in virtualized environments or cloud-based environments where control over the network is limited. The database firewall can only block traffic when placed in-line with the network traffic flowing to the database, so this will always be the deployment model when blocking is required.

The database firewall can be positioned out-of-band with the network traffic, with traffic destined for the database server copied to the database using a network SPAN port, a network tap, or a network packet replicator – as long as the database firewall can “see” the SQL statements flowing to the database, and the database’s response to those statements, the technology used doesn’t matter. This is the most-used deployment model for on-premises deployments where blocking is not required.

Host Monitor

In cases where it is impractical to either route traffic through or copy traffic to the database firewall, a host monitor may be used. Host monitors capture network activity at the database server, and forward that to the database firewall for analysis. Host monitors are another common deployment option in virtualized environments.

Capabilities

All three of the database firewall deployment modes allow for monitoring activity. Only the in-line proxy allows blocking.

Deployment Mode	Details	Monitoring?	Blocking?
In-line Proxy	All client connections go via firewall, including return traffic	Yes	Yes
Host Monitor	Agent running on database host listening to incoming traffic	Yes	No
Out-of-Band	Monitors DB traffic sent to it by a SPAN port or packet replicator	Yes	No

Table 1 Database Firewall deployment model

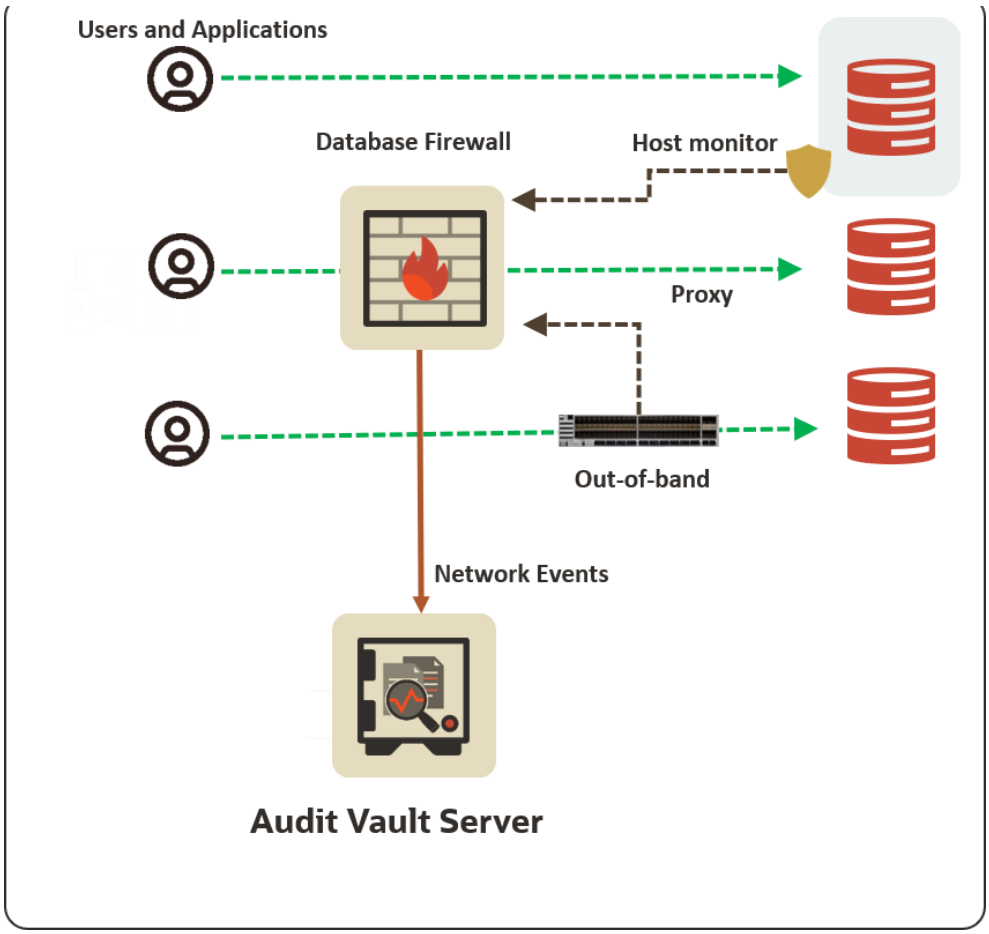

Figure 10 - Database Firewall Deployment Options

High Availability

Both the audit vault server and the database firewall can be configured in pairs to provide a high-availability system architecture. These paired servers are known as *resilient pairs*.

Audit Vault Server High Availability

When configured as a resilient pair, the audit vault server has a primary server, which performs all server functions, and a secondary server, which is kept in synchronization with the primary using Oracle Data Guard. If the primary audit vault server fails, the secondary automatically comes online, and both audit vault agents and database firewalls will begin sending their data to the secondary.

Database Firewall High Availability

There are two forms of database firewall high availability, and which is used depends on whether the database firewall is being used in proxy mode or in one of the monitoring-only configurations.

Database Firewall and High Availability in an Out-of-Band or Host Monitor Configuration

In monitoring mode, the database firewall is configured as a resilient pair, with configuration for both synchronized by the audit vault server. There is no communication between the primary and secondary database firewall – both act independently of the other. The primary and secondary database firewalls receive the same traffic, and both send their logs to the audit vault server. The audit vault server only processes logs from the primary, ignoring and discarding logs from the secondary until the primary becomes unavailable.

Database Firewall and High Availability in a Proxy Configuration

When a database firewall is used in a proxy configuration, two or more database firewalls may be used to achieve the level of fault tolerance desired.

Traffic may be directed to the database firewalls from a load balancer, by DNS, or by using client-based configurations like load-balance or transparent application failover.

All firewalls in the configuration are online (there is no concept of primary/standby for in-line), and the audit vault server processes logs from all the database firewalls.

Integration with third-party solutions

Oracle Audit Vault and Database Firewall can integrate with third-party security solutions like a SIEM, Splunk, or log aggregator either by *pushing* data to them or by allowing the third-party solution to *pull* data directly from the audit repository.

Data is *pushed* to a third party by sending alerts via Syslog. The content and the format of these alert messages are fully customizable. Auditors can define an unlimited number of message templates and apply them to different alert definitions.

Third-party solutions can *pull* data from AVDF by connecting directly to the audit repository to extract audit data for further analysis and correlation with other data feeds. Third-party access to audit data is controlled by the same privilege model used for AVDF auditors, so it is possible to only provide access to certain subsets of audit information.

Conclusion

Oracle Audit Vault and Database Firewall helps organizations increase security by proactively assessing the security posture of databases, monitoring database activity on the network and inside the database, protecting against SQL injection threats, consolidating audit data into a secure and scalable repository, and automating reporting to support audit and compliance activities. Extensive reporting and alerting capabilities provide auditors and security personnel with access to detailed information and early warning alerts on potential malicious activity. Sources beyond databases

can be monitored, with out-of-the-box support for the consolidation of audit data from various operating systems and directory services. An extensible plug-in architecture enables custom audit sources to be added to the collection framework, enabling application-specific audit data to be aggregated and reported together with other event data in the repository. Audit Vault and Database Firewall deliver effective detective and preventive controls for Oracle and non-Oracle databases alike.

AVDF was already a best-in-class provider for database auditing and activity monitoring platform. Now with comprehensive security posture management for your enterprise, the discovery of sensitive data, and privileged user capabilities, AVDF becomes a one-stop solution for assessing, discovering, monitoring, and protecting the most critical asset of the organization which is data.

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