Oracle AVDF

Oracle Audit Vault and Database Firewall
at a glance

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2. Auflage

DER ORACLE DBA

Handbuch für die Administration der Oracle Database 12c

EXTRA: E-Book inside

Im Internet: sqlplus-Kommandos, Datentypen, v$ Views u.v.m.

HANSER

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Tech Architecture Manager

- Since 1997 active in various IT areas
- More than 25 years of experience in Oracle databases
- Focus: Protecting data and operating databases securely
  - Security assessments and reviews
  - Database security concepts and their implementation
  - Oracle Backup & Recovery concepts and troubleshooting
  - Oracle Enterprise User and Advanced Security, DB Vault, …
  - Oracle Directory Services
- Co-author of the book The Oracle DBA (Hanser, 2016/07)

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DATA PLATFORMS

WHY? We are the game changer for our client's data platform projects

HOW? Maximum automation, maximum efficiency, maximum quality!

WHAT? We build innovative data platforms based on our blueprints, assets and tools.

3 key benefits

1 Architecture expertise from hands-on projects

2 Delivery of tailor-made data platforms

3 Integrated Teams - Like a Rowing team, perfect alignment and interaction.

Tools and Blueprints

Key enabler for the implementation of modern data platforms at a high speed and quality.

Continuous Optimization

Tools and Blueprints are continuously optimized to the customer and project’s needs.

Expertise

Expert group for modern data platforms from technical implementation to project management and organization

Oracle AVDF

What to expect with the latest version of Oracle AVDF?

1 Introduction

2 AVDF in a Nutshell

3 Use Cases

4 Latest Enhancements

5 Best Practice

6 Licensing

7 Other Solutions

8 Conclusion

1

Introduction

Why is Oracle AVDF needed at all?

Introduction

Motivation for Oracle ADVF

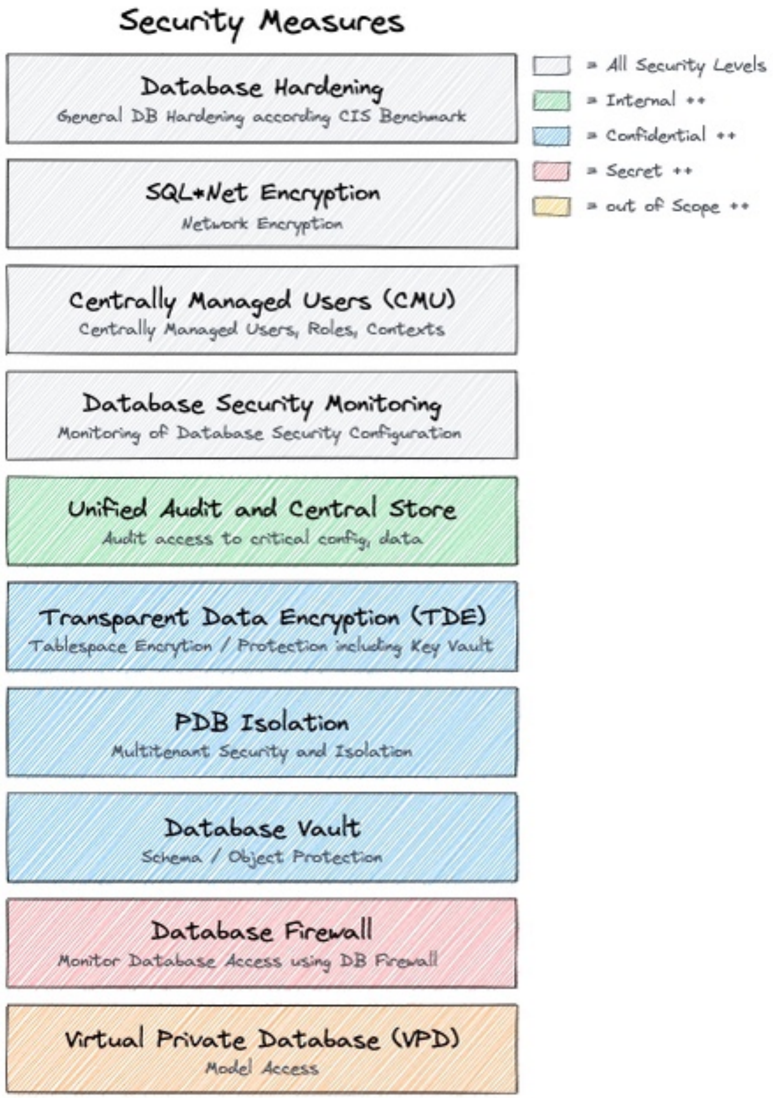
Why Database Security at all?

- Protection of **company** and its business
- Protection of **employees**, **customers** and others
- and of course, **compliance** and **regulatory** requirements

Security measures are complex and expensive

- **Management** of security configuration e.g., Audit
- Availability of **Security Options** and **Features** (Edition, License etc.)
- **Segregation of Duties** e.g., DBAs audit themselves?
- Traceability and auditability

Oracle Audit Vault and Database Firewall as Audit warehouse, Audit management and security measure enforcement tool



Security Measures
Database Hardening
General DB Hardening according CIS Benchmark
SQL*Net Encryption
Network Encryption
Centrally Managed Users (CMU)
Centrally Managed Users, Roles, Contexts
Database Security Monitoring
Monitoring of Database Security Configuration
Unified Audit and Central Store
Audit access to critical config, data
Transparent Data Encryption (TDE)
Tablespace Encrytion / Protection including Key Vault
PDB Isolation
Multitenant Security and Isolation
Database Vault
Schema / Object Protection
Database Firewall
Monitor Database Access using DB Firewall
Virtual Private Database (VPD)
Model Access
⬜ = All Security Levels
🟩 = Internal ++
🟦 = Confidential ++
🟥 = Secret ++
🟨 = out of Scope ++

2

AVDF in a Nutshell

Architecture, Structure and Functionality of AVDF

Software Appliance

Everything bundled…

Oracle provides software as Appliance

- ISO image containing OS, Database and Application
- Dedicated ISO for Audit Vault and Database Firewall

Customer delivers the hardware

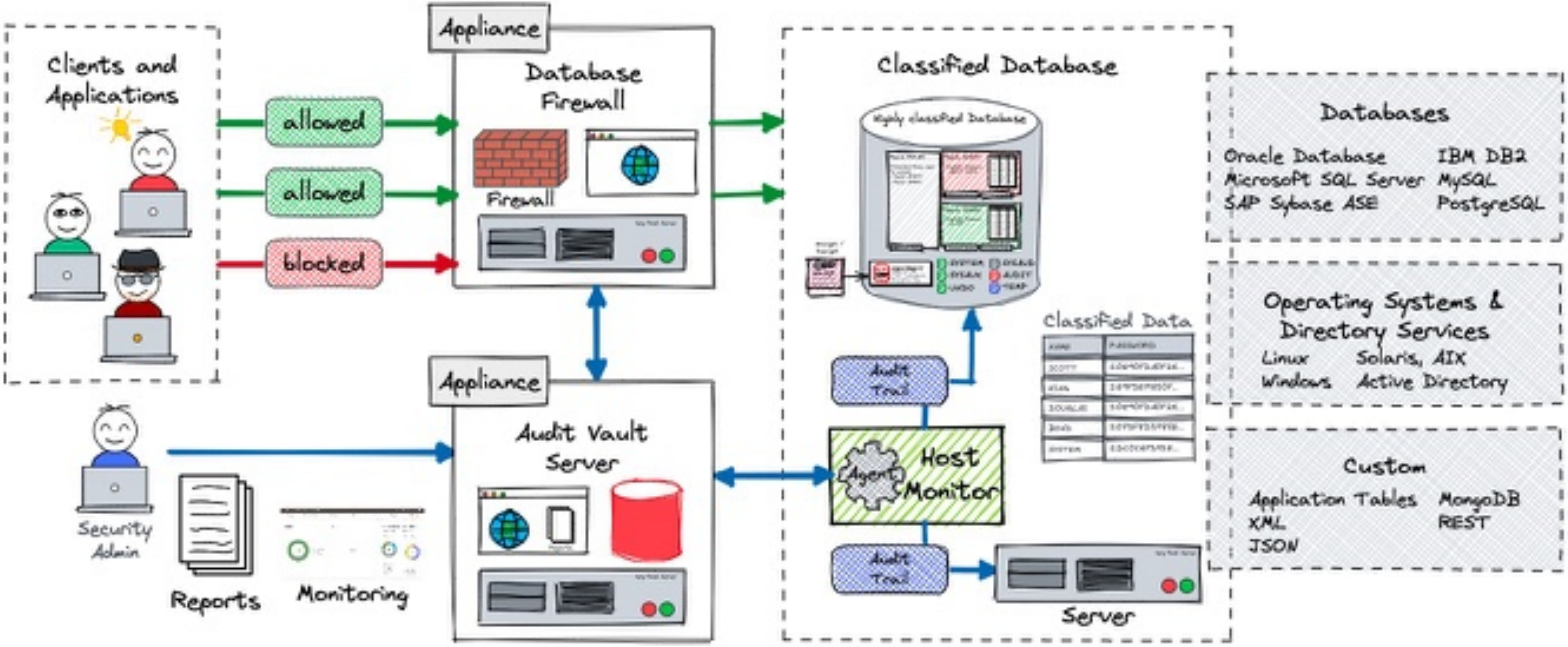
- Dedicated x86-64 server or virtual machine
- Simplified setup to install everthing in one step
- Reduced Access / Segragation of Duties

Oracle Cloud deployment

- Simplified installation based on Market place images
- Ideal for tests and proof of concepts

Oracle AVDF Architecture

Components at a glance



Oracle AVDF Architecture

Out-of-the-Box Plug-ins and Features Supported

Target Version	Audit Trail Collection	Audit Policy Creation	Stored Procedure Auditing	Audit Trail Clean up	Database Firewall	Host Monitor Agent	Native Network Encrypted Traffic
Oracle Database 11.2	✓	✓	✓	✓	✓	✓	✓
Oracle Database 12c, 18c, 19c	✓	✓	✓	✓	✓	✓	✓
MS SQL Server 2012, 2014, 2016, 2017, 2019	✓		✓	✓	✓	✓	✓
MS SQL Server 2012 R2 (Windows Clustered)	✓		✓	✓			
SAP Sybase ASE 15.7, 16	✓		✓		✓	✓	
IBM 10.5, 11.1, 11.5	✓			✓	✓	✓	✓
MySQL 5.6, 5.7, 8.0	✓			✓	✓	✓	
PostgresSQL 9.6 to 11.8, 12, 13	✓			✓	✓	✓	

Oracle AVDF Architecture

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Oracle Solaris 11.x up to 11.4 on	✓					✓	
Oracle Linux 6.0 - 6.10, 7.0 - 7.3, 7.4, 7.5, 7.8, 8, 8.2, 8.3, 9	✓					✓	
RedHat Linux 6.8 - 6.10, 7.3 - 7.8, 9	✓					✓	
IBM AIX 7.1 TL5, 7.2 (TL2, TL3, TL4) on Power Systems	✓					✓	
Microsoft Windows Server 2012, 2012 R2, 2016, and 2019	✓						
Microsoft Active Directory 2012, 2012 R2, and 2016	✓						
Oracle ACFS 12c	✓						

Segregation of Duty

Enforcement of the separation of responsibilities

AV Administrator

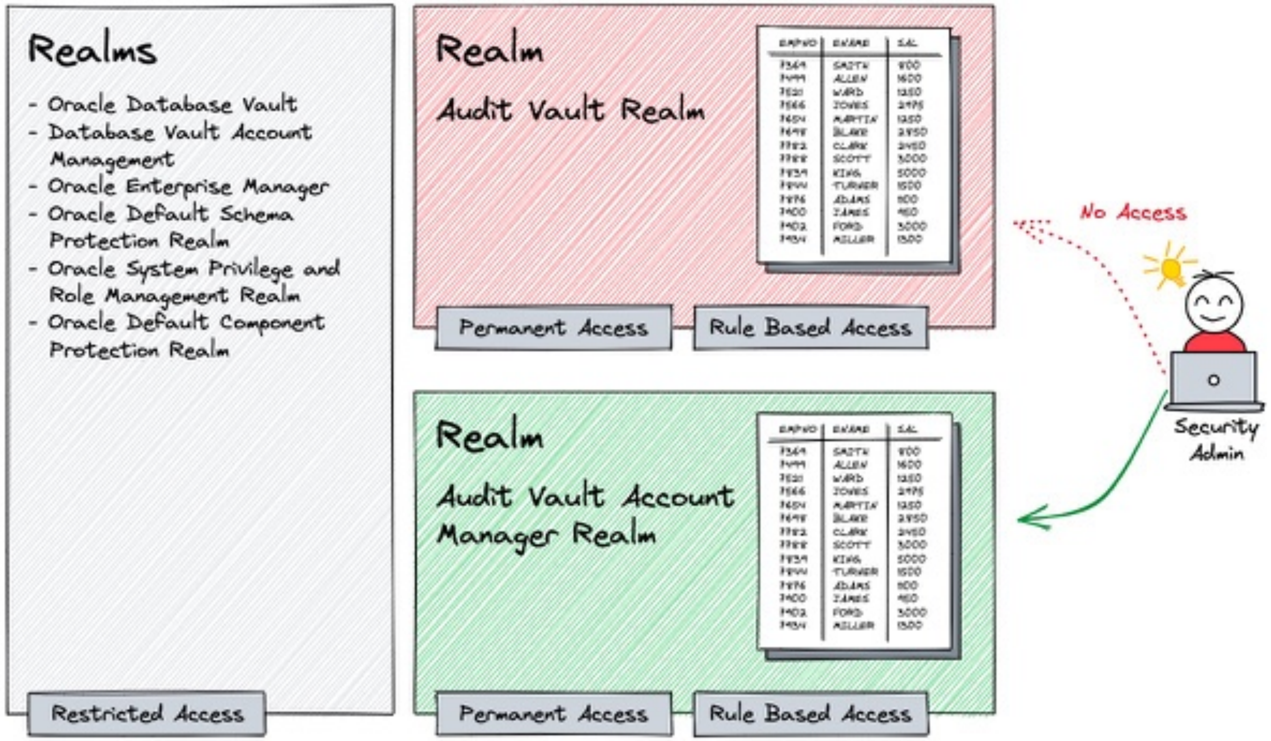
- Maintain AVDF infrastructure
- Deploy AV agents

AV Auditor

- Define audit policies
- Define firewall rules
- Report and Assessments

Infrastructure Admin

- Operate and maintain Infrastructure e.g., storage, vm


Realms
- Oracle Database Vault
- Database Vault Account Management
- Oracle Enterprise Manager
- Oracle Default Schema Protection Realm
- Oracle System Privilege and Role Management Realm
- Oracle Default Component Protection Realm
Restricted Access
Realm
Audit Vault Realm
Permanent Access
Rule Based Access
Realm
Audit Vault Account Manager Realm
Permanent Access
Rule Based Access
No Access
Security Admin

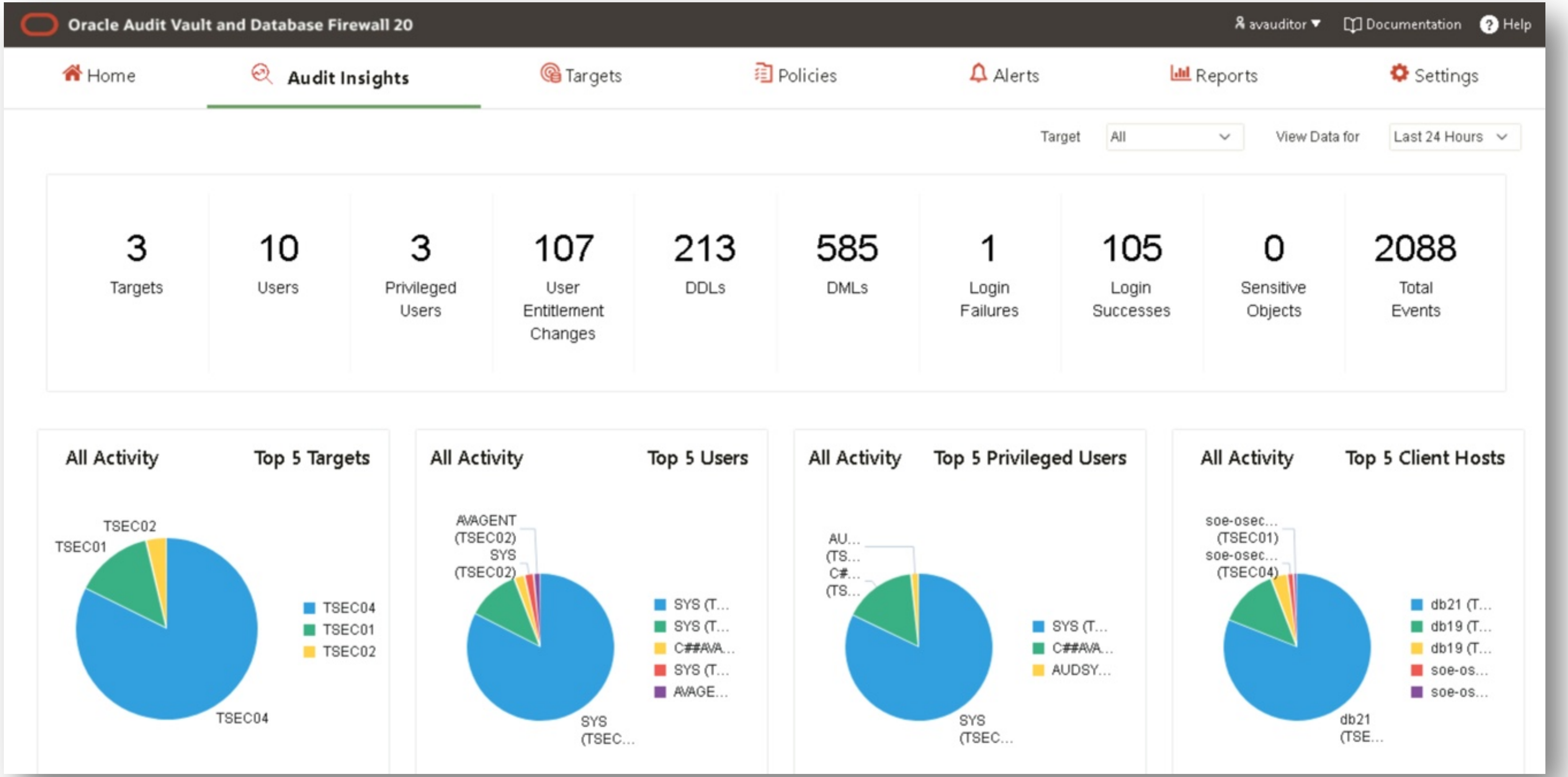
3

Use Cases

Or how AVDF can be used in a meaningful way

Use Cases

Central Audit Management – one place to store, one view



Oracle Audit Vault and Database Firewall 20

Target: All

View Data for: Last 24 Hours

3	10	3	107	213	585	1	105	0	2088
Targets	Users	Privileged Users	User Entitlement Changes	DDLs	DMLs	Login Failures	Login Successes	Sensitive Objects	Total Events

All Activity — Top 5 Targets

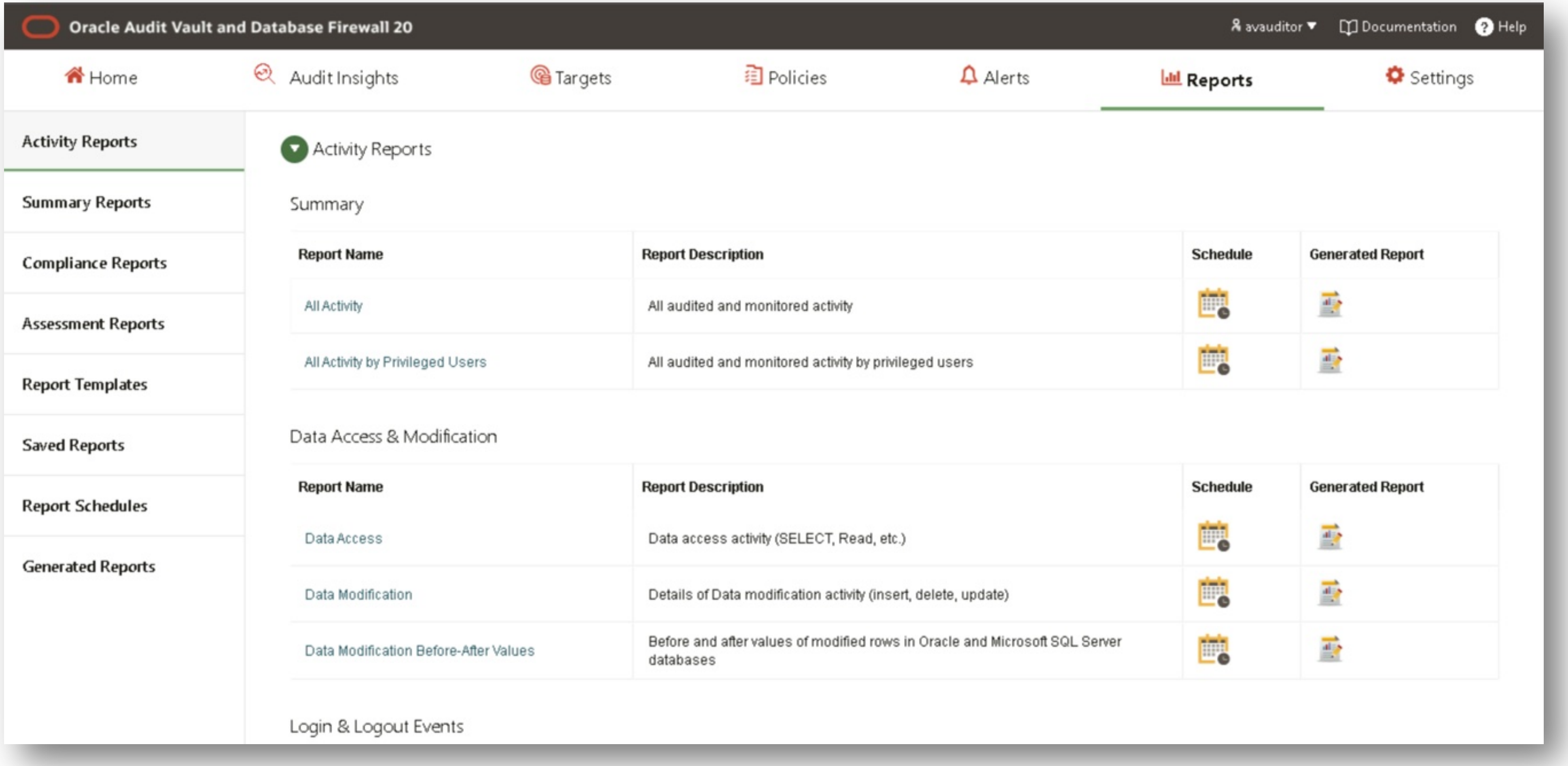
All Activity — Top 5 Users

All Activity — Top 5 Privileged Users

All Activity — Top 5 Client Hosts

Use Cases

Activity and Compliance Reporting – Predefined Reports



Activity Reports

Summary

Report Name	Report Description	Schedule	Generated Report
All Activity	All audited and monitored activity		
All Activity by Privileged Users	All audited and monitored activity by privileged users		

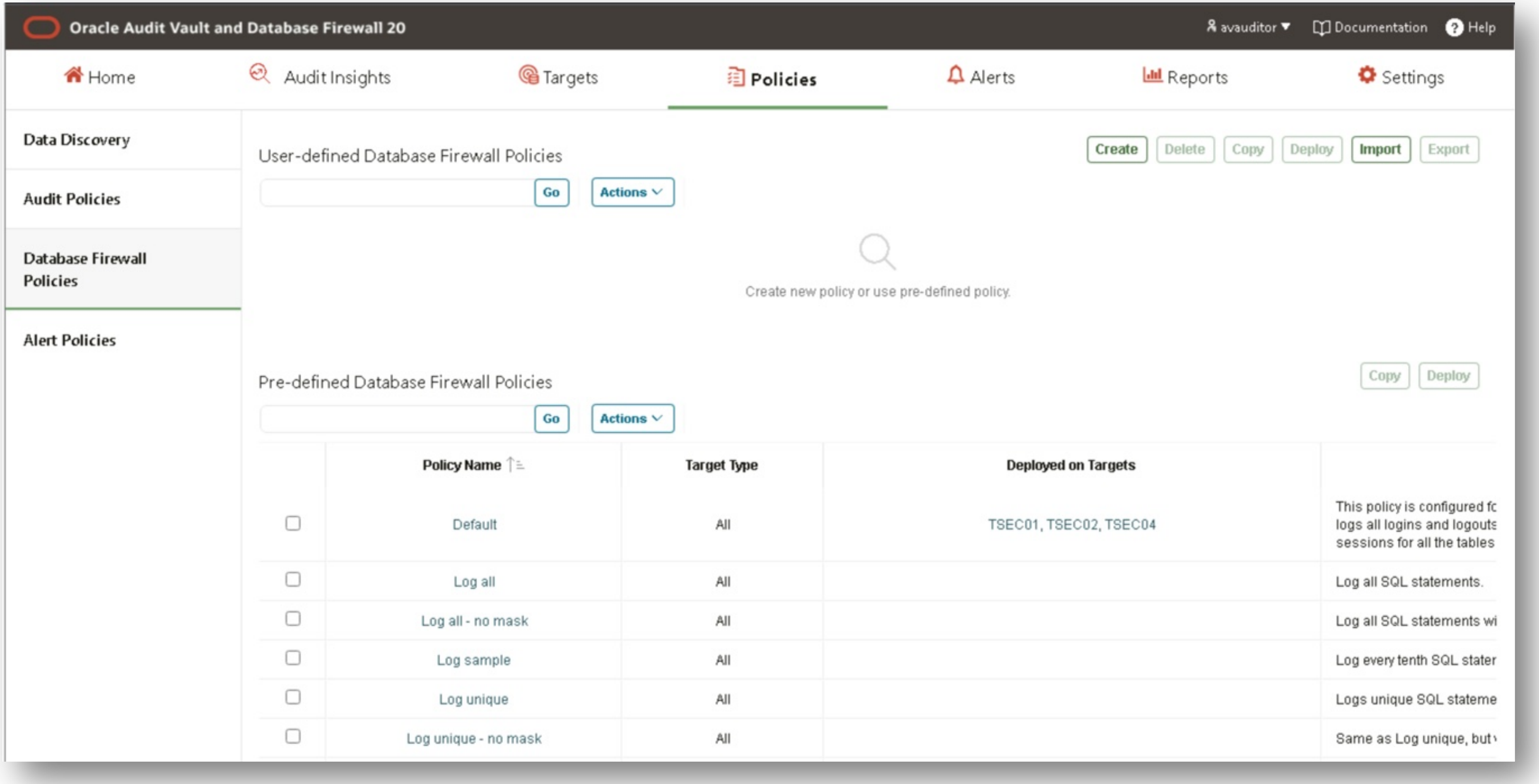
Data Access & Modification

Report Name	Report Description	Schedule	Generated Report
Data Access	Data access activity (SELECT, Read, etc.)		
Data Modification	Details of Data modification activity (insert, delete, update)		
Data Modification Before-After Values	Before and after values of modified rows in Oracle and Microsoft SQL Server databases		

Login & Logout Events

Use Cases

Database Firewall – Place where the real work begins



User-defined Database Firewall Policies

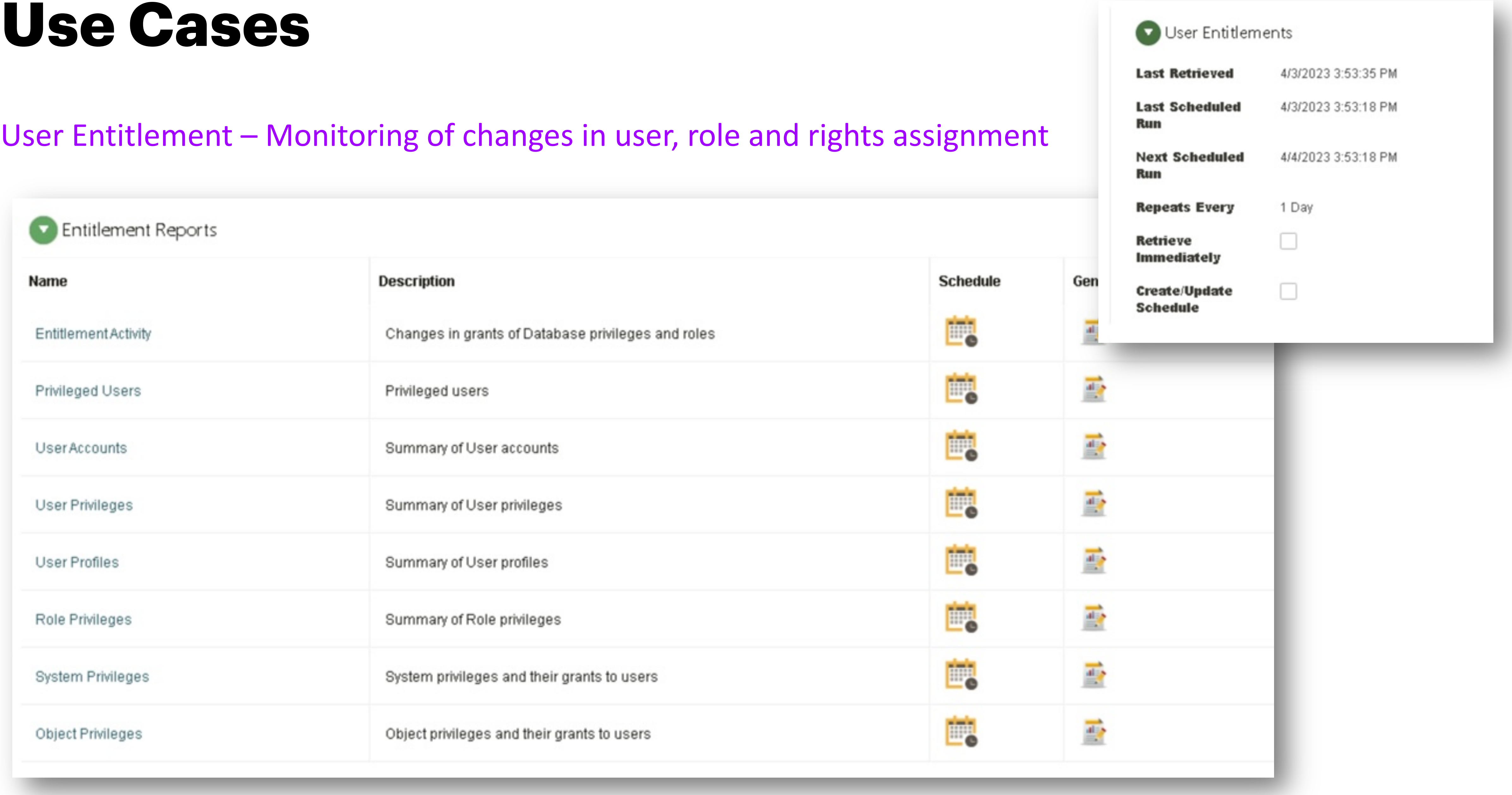
Create new policy or use pre-defined policy.

Pre-defined Database Firewall Policies

	Policy Name	Target Type	Deployed on Targets	
☐	Default	All	TSEC01, TSEC02, TSEC04	This policy is configured fc logs all logins and logouts sessions for all the tables
☐	Log all	All		Log all SQL statements.
☐	Log all - no mask	All		Log all SQL statements wi
☐	Log sample	All		Log every tenth SQL stater
☐	Log unique	All		Logs unique SQL stateme
☐	Log unique - no mask	All		Same as Log unique, but

Use Cases

User Entitlement – Monitoring of changes in user, role and rights assignment



Entitlement Reports

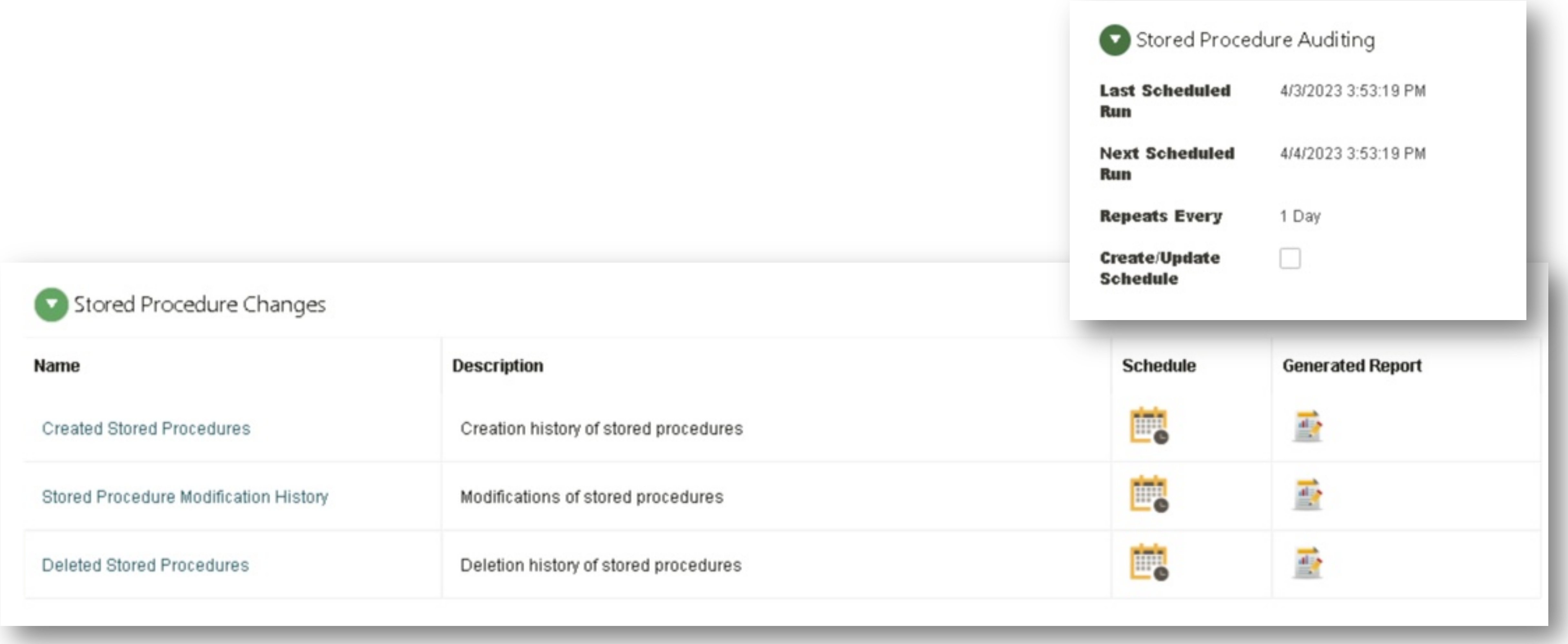
Name	Description	Schedule	Gen
Entitlement Activity	Changes in grants of Database privileges and roles		
Privileged Users	Privileged users		
User Accounts	Summary of User accounts		
User Privileges	Summary of User privileges		
User Profiles	Summary of User profiles		
Role Privileges	Summary of Role privileges		
System Privileges	System privileges and their grants to users		
Object Privileges	Object privileges and their grants to users		

User Entitlements

Last Retrieved	4/3/2023 3:53:35 PM
Last Scheduled Run	4/3/2023 3:53:18 PM
Next Scheduled Run	4/4/2023 3:53:18 PM
Repeats Every	1 Day
Retrieve Immediately	□
Create/Update Schedule	□

Use Cases

Store Procedure Audit – Track if, when and by whom changes have been made



Stored Procedure Auditing

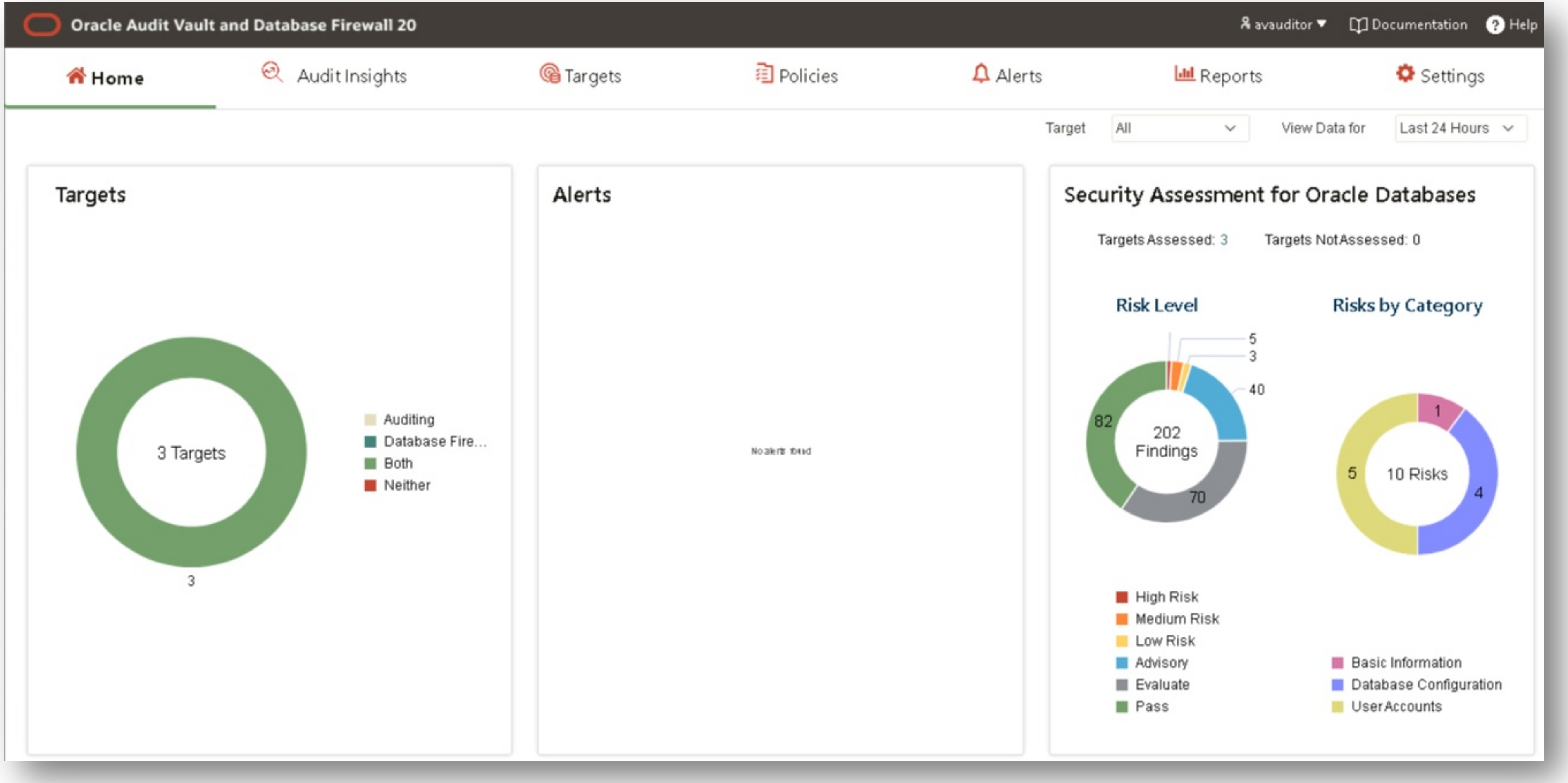
Last Scheduled Run	4/3/2023 3:53:19 PM
Next Scheduled Run	4/4/2023 3:53:19 PM
Repeats Every	1 Day
Create/Update Schedule	□

Stored Procedure Changes

Name	Description	Schedule	Generated Report
Created Stored Procedures	Creation history of stored procedures	📅	📝
Stored Procedure Modification History	Modifications of stored procedures	📅	📝
Deleted Stored Procedures	Deletion history of stored procedures	📅	📝

Use Cases

Database Security Assessments



Target: All

View Data for: Last 24 Hours

Targets

Alerts

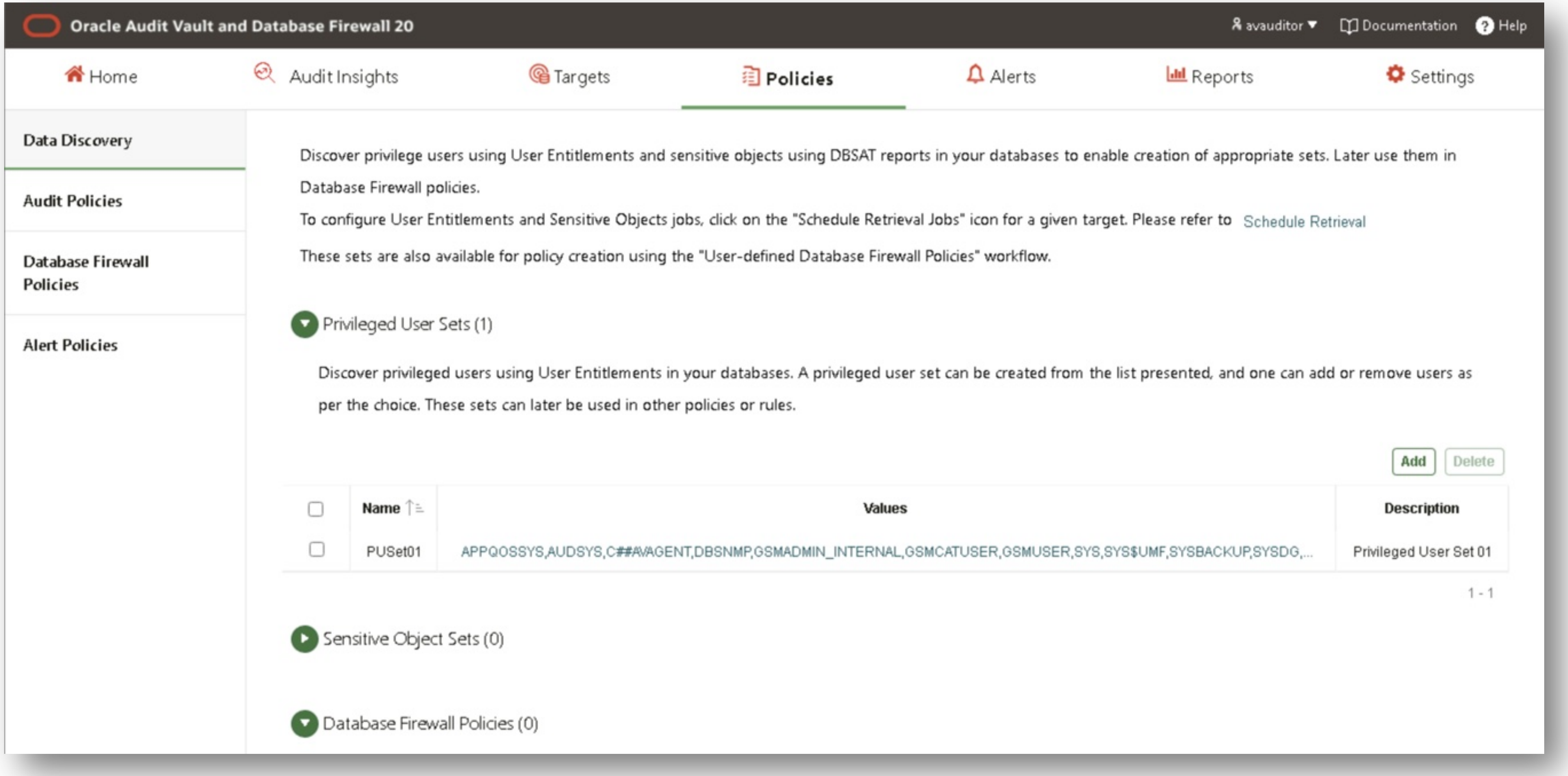
No alerts found

Security Assessment for Oracle Databases

Targets Assessed: 3 Targets Not Assessed: 0

Use Cases

Privileges Users and Sensitiv Object Discovery



Discover privilege users using User Entitlements and sensitive objects using DBSAT reports in your databases to enable creation of appropriate sets. Later use them in Database Firewall policies.

To configure User Entitlements and Sensitive Objects jobs, click on the "Schedule Retrieval Jobs" icon for a given target. Please refer to Schedule Retrieval

These sets are also available for policy creation using the "User-defined Database Firewall Policies" workflow.

Privileged User Sets (1)

Discover privileged users using User Entitlements in your databases. A privileged user set can be created from the list presented, and one can add or remove users as per the choice. These sets can later be used in other policies or rules.

□	Name	Values	Description
□	PUSet01	APPQOSSYS,AUDSYS,C##AVAGENT,DBSNMP,GSMADMIN_INTERNAL,GSMCATUSER,GSMUSER,SYS,SYS$UMF,SYSBACKUP,SYSDG,...	Privileged User Set 01

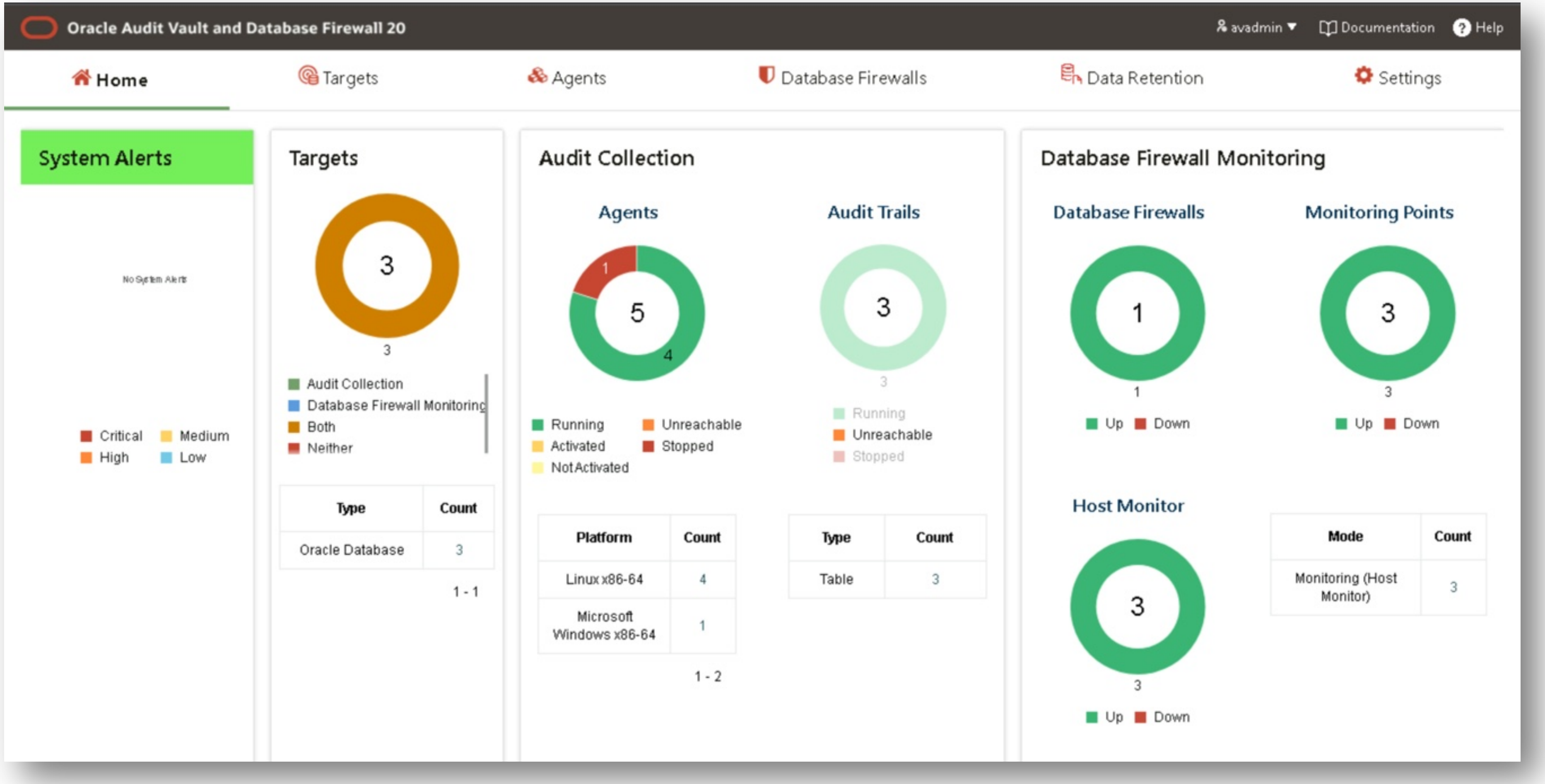
1 - 1

Sensitive Object Sets (0)

Database Firewall Policies (0)

Use Cases

AVDF Infrastructure Administration – Archiving, High Availability, and more…



Type	Count
Oracle Database	3

1 - 1

Platform	Count
Linux x86-64	4
Microsoft Windows x86-64	1

1 - 2

Type	Count
Table	3

Mode	Count
Monitoring (Host Monitor)	3

4

Latest Enhancements

Oracle AVDF 20.9 and earlier

Releases Support Notes

General Notes about Oracle AVDF enhancements

New versions of AVDF are released on a regular basis

- Released about **twice a year** see Oracle Support Document 1328209.1
  - AVDF Release Update 7 (RU7) June 2022
  - AVDF Release Update 8 (RU8) September 2022
  - AVDF Release Update 9 (RU9) March 2023
- **Release Update** includes…
  - critical functional and security fixes e.g. Oracle Critical Patch Updates for the whole stack
  - New features and enhancements
- Covers all components e.g. **Audit Vault** and **Database Firewall**

It is recommendet to stay up to date…

Latest Enhancements

Oracle AVDF Release 20.9

- **Security Assessment** centralized security assessment solution for enterprises by integrating the popular Database Security Assessment Tool (DBSAT)
- **Discover sensitive objects and privileged users** AVDF 20.9 now helps customers discover sensitive data and privileged users in the Oracle database
- **Audit Insights** Customers can now get immediate insight into the top user activities across one or multiple databases
- **Before/After reporting for Microsoft SQL Server** The Before/After report for the Microsoft SQL server is a valuable addition to the already available before/after report for the Oracle database, helping organizations improve their compliance posture
- **Data Retention** Administrators can streamline data retention with a simplified lifecycle management process and a target-focused view

Latest Enhancements

Oracle AVDF Release 20.9

- **Agentless Audit Collection** It is now possible to accelerate the deployment of AVDF with the agentless audit collection service for Oracle databases. There's no need for agent installation or upgrades on target Oracle databases. Ideal for small or remote deployments and proof of concepts.
- **System Alerts** Administrators can now be alerted on the status of critical AVDF changes, such as high availability configuration, storage availability, certificate expiration, and password expiration.
- **Out-of-Place Upgrade** Increase system availability during updates and upgrades with minimal downtime, typically in minutes.
- **Upgraded Platform** The operating system for the Oracle Audit Vault Server and Database Firewall Server has been updated to Oracle Linux 8.

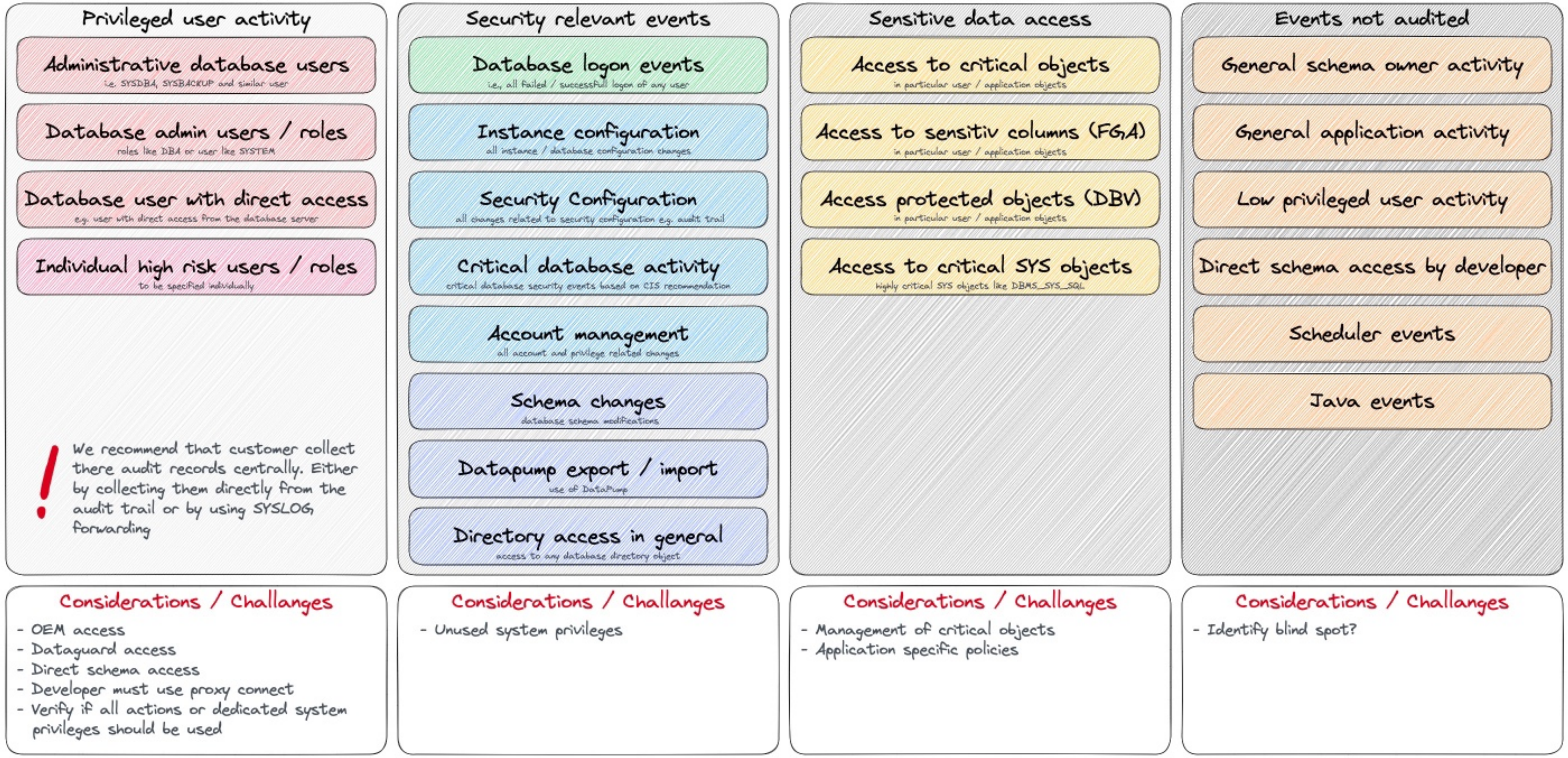
5

Best Practice

Tips on how to avoid common mistakes

Oracle Audit Concept

Comprehensive audit concept independent of AVDF



Privileged user activity

- Administrative database users
  i.e. SYSDBA, SYSBACKUP and similar user
- Database admin users / roles
  roles like DBA or user like SYSTEM
- Database user with direct access
  e.g. user with direct access from the database server
- Individual high risk users / roles
  to be specified individually

! We recommend that customer collect there audit records centrally. Either by collecting them directly from the audit trail or by using SYSLOG forwarding

Considerations / Challanges

- OEM access
- Dataguard access
- Direct schema access
- Developer must use proxy connect
- Verify if all actions or dedicated system privileges should be used

Security relevant events

- Database logon events
  i.e., all failed / successfull logon of any user
- Instance configuration
  all instance / database configuration changes
- Security Configuration
  all changes related to security configuration e.g. audit trail
- Critical database activity
  critical database security events based on CIS recommendation
- Account management
  all account and privilege related changes
- Schema changes
  database schema modifications
- Datapump export / import
  use of DataPump
- Directory access in general
  access to any database directory object

Considerations / Challanges

- Unused system privileges

Sensitive data access

- Access to critical objects
  in particular user / application objects
- Access to sensitiv columns (FGA)
  in particular user / application objects
- Access protected objects (DBV)
  in particular user / application objects
- Access to critical SYS objects
  highly critical SYS objects like DBMS_SYS_SQL

Considerations / Challanges

- Management of critical objects
- Application specific policies

Events not audited

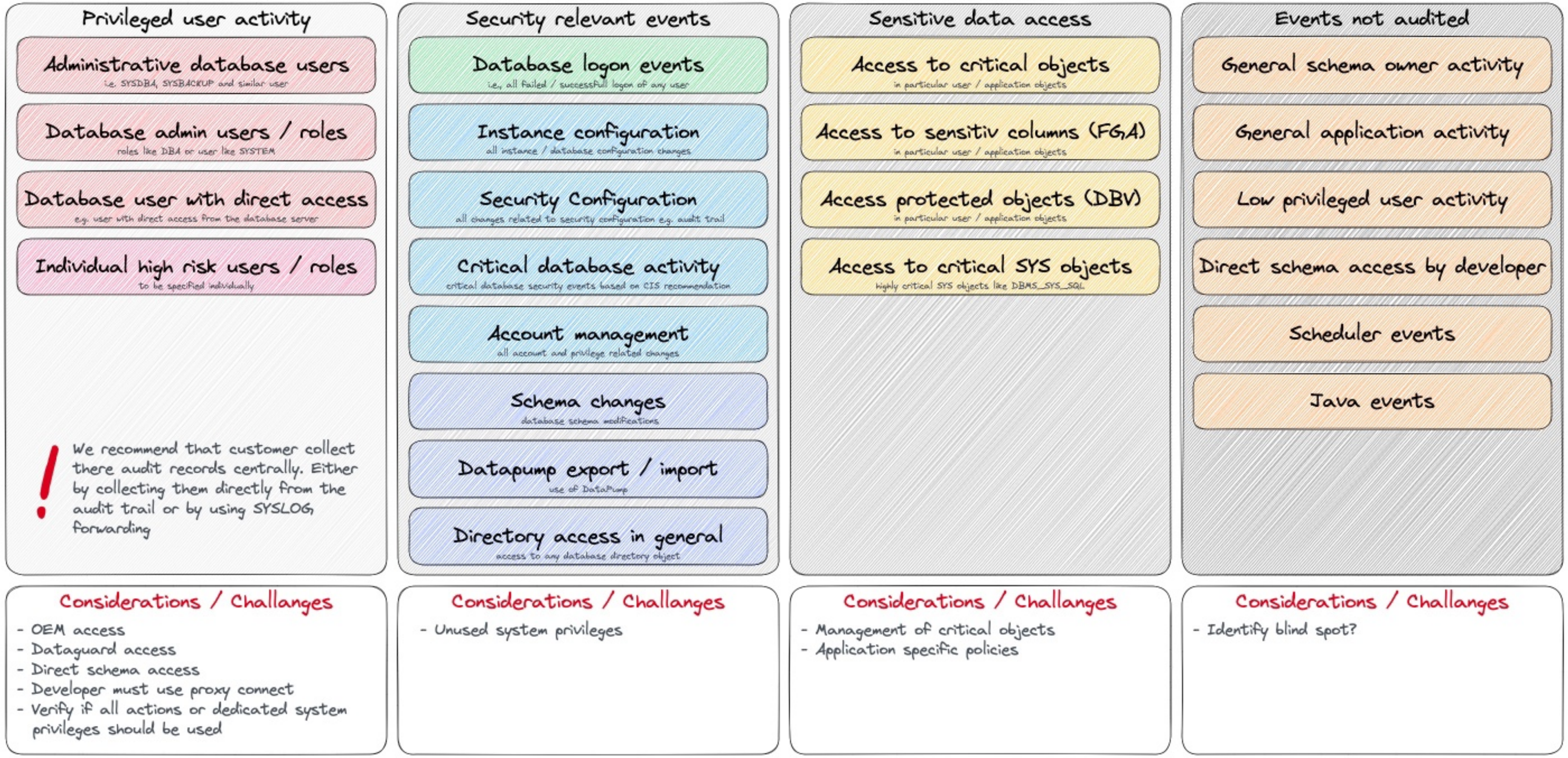
- General schema owner activity
- General application activity
- Low privileged user activity
- Direct schema access by developer
- Scheduler events
- Java events

Considerations / Challanges

- Identify blind spot?

Oracle Audit Concept

Comprehensive audit concept independent of AVDF



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General application activity

Low privileged user activity

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Scheduler events

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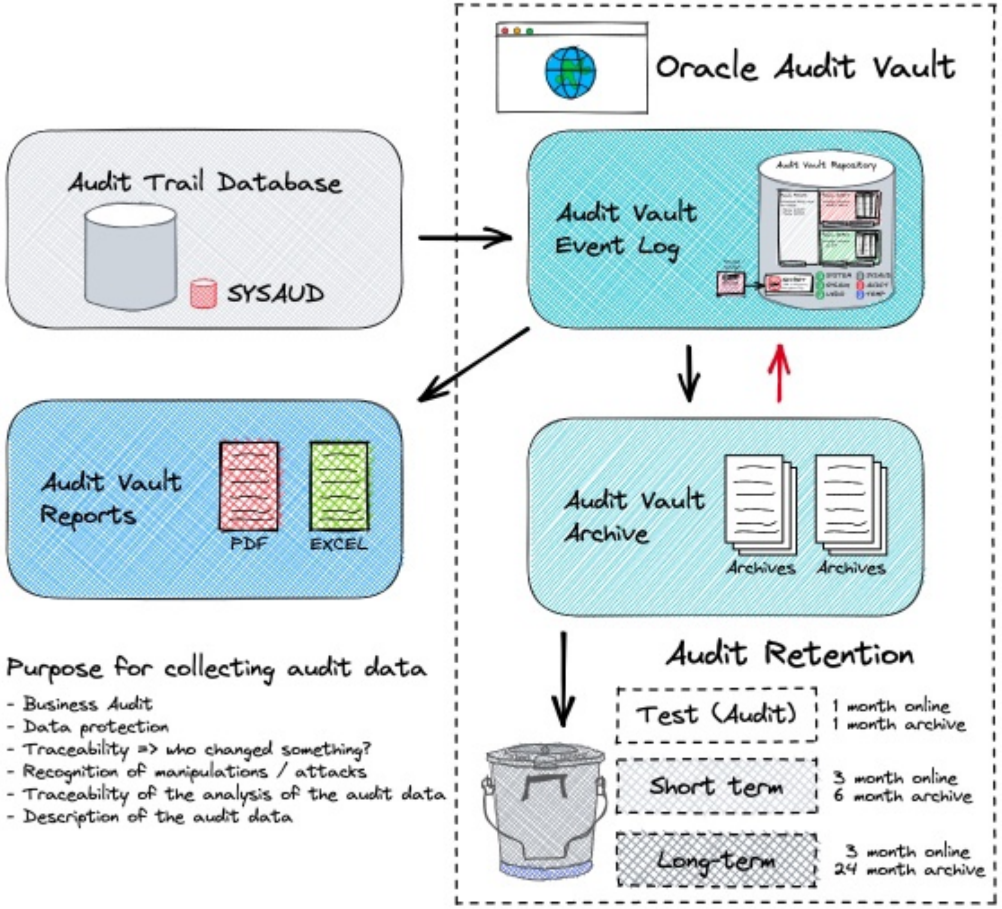
Considerations / Challanges
- Identify blind spot?

It is essential that you have your audit settled before deploying AVDF

Data Retention

Keep the beast in check!



Audit Trail: decentral source of audit data

- Storage requirements on source system, relatively cost intensive, risk of data tampering, no overall analysis

Audit Vault Event Log: central online storage of audit data

- Detailed central audit information, overall analysis, Appliance size sets storage limits

Audit Vault Archives: offline storage of audit data

- Offline archive freeing storage on Audit Vault server, must be brought back online for analysis

Audit Vault Reports: summarized audit informations

- consolidated information, low memory requirements, long-term storage possible

The retention period of audit data determines storage needs

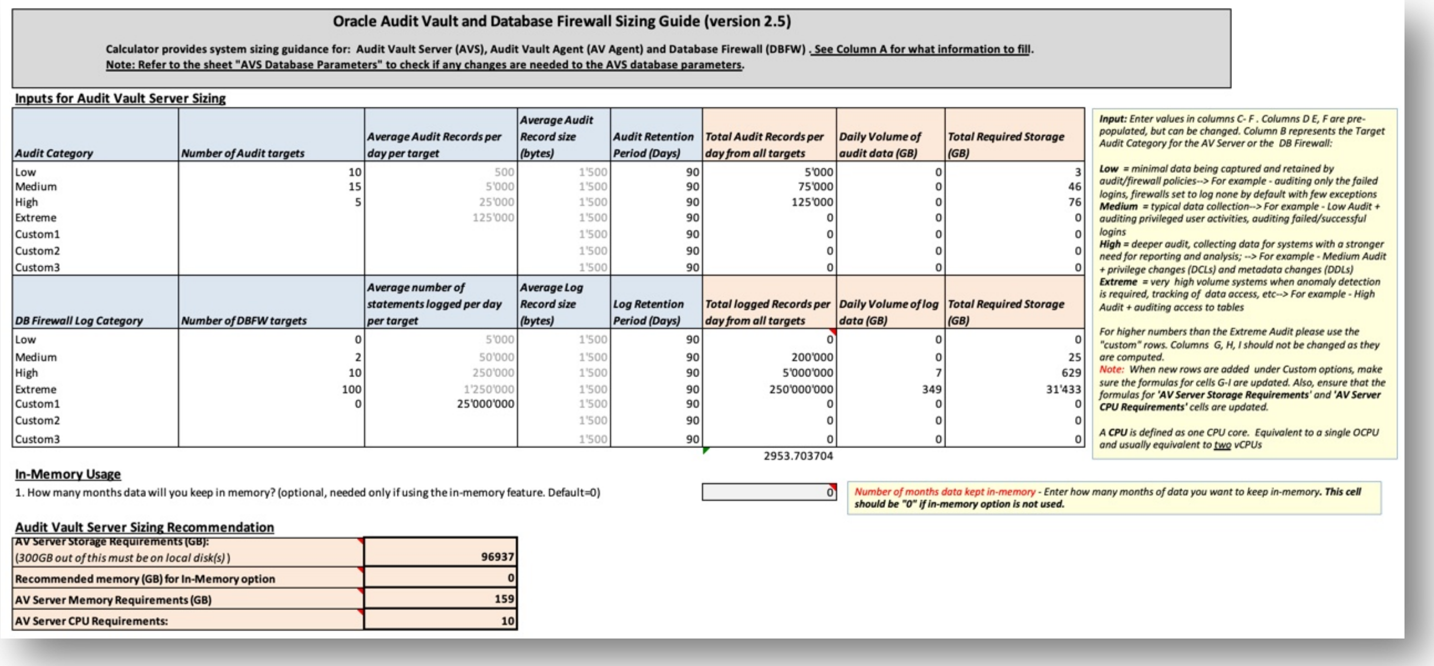
Choose wisely where to store data and for how long

Sizing

As much as necessary not as much as possible…

Driver for Audit Vault and Firewall Sizing

- **Audit Policies / Trails**
  - Type of audit trails
  - Size of audit records
  - Number of audit trails
- **Retention** period of the data
  - What and how long
  - Business and compliance needs



Oracle Audit Vault and Database Firewall Sizing Guide (version 2.5)

Calculator provides system sizing guidance for: Audit Vault Server (AVS), Audit Vault Agent (AV Agent) and Database Firewall (DBFW) . See Column A for what information to fill.
Note: Refer to the sheet "AVS Database Parameters" to check if any changes are needed to the AVS database parameters.

Inputs for Audit Vault Server Sizing

Audit Category	*Number of Audit targets*	*Average Audit Records per day per target*	*Average Audit Record size (bytes)*	*Audit Retention Period (Days)*	*Total Audit Records per day from all targets*	*Daily Volume of audit data (GB)*	*Total Required Storage (GB)*
Low	10	500	1'500	90	5'000	0	3
Medium	15	5'000	1'500	90	75'000	0	46
High	5	25'000	1'500	90	125'000	0	76
Extreme		125'000	1'500	90	0	0	0
Custom1			1'500	90	0	0	0
Custom2			1'500	90	0	0	0
Custom3			1'500	90	0	0	0

DB Firewall Log Category	*Number of DBFW targets*	*Average number of statements logged per day per target*	*Average Log Record size (bytes)*	*Log Retention Period (Days)*	*Total logged Records per day from all targets*	*Daily Volume of log data (GB)*	*Total Required Storage (GB)*
Low	0	5'000	1'500	90	0	0	0
Medium	2	50'000	1'500	90	200'000	0	25
High	10	250'000	1'500	90	5'000'000	7	629
Extreme	100	1'250'000	1'500	90	250'000'000	349	31'433
Custom1	0	25'000'000	1'500	90	0	0	0
Custom2			1'500	90	0	0	0
Custom3			1'500	90	0	0	0
					2953.703704		

__Input:__ Enter values in columns C- F . Columns D E, F are pre-populated, but can be changed. Column B represents the Target Audit Category for the AV Server or the DB Firewall:

***Low** = minimal data being captured and retained by audit/firewall policies--> For example - auditing only the failed logins, firewalls set to log none by default with few exceptions*
***Medium** = typical data collection--> For example - Low Audit + auditing privileged user activities, auditing failed/successful logins*
***High** = deeper audit, collecting data for systems with a stronger need for reporting and analysis; --> For example - Medium Audit + privilege changes (DCLs) and metadata changes (DDLs)*
***Extreme** = very high volume systems when anomaly detection is required, tracking of data access, etc--> For example - High Audit + auditing access to tables*

For higher numbers than the Extreme Audit please use the "custom" rows. Columns G, H, I should not be changed as they are computed.
*Note: When new rows are added under Custom options, make sure the formulas for cells G-I are updated. Also, ensure that the formulas for **'AV Server Storage Requirements'** and **'AV Server CPU Requirements'** cells are updated.*

*A **CPU** is defined as one CPU core. Equivalent to a single OCPU and usually equivalent to two vCPUs*

In-Memory Usage

1. How many months data will you keep in memory? (optional, needed only if using the in-memory feature. Default=0) 0

*Number of months data kept in-memory - Enter how many months of data you want to keep in-memory. **This cell should be "0" if in-memory option is not used.***

Audit Vault Server Sizing Recommendation

AV Server Storage Requirements (GB): *(300GB out of this must be on local disk(s))*	**96937**
Recommended memory (GB) for In-Memory option	**0**
AV Server Memory Requirements (GB)	**159**
AV Server CPU Requirements:	**10**

Oracle Calculation Guideline

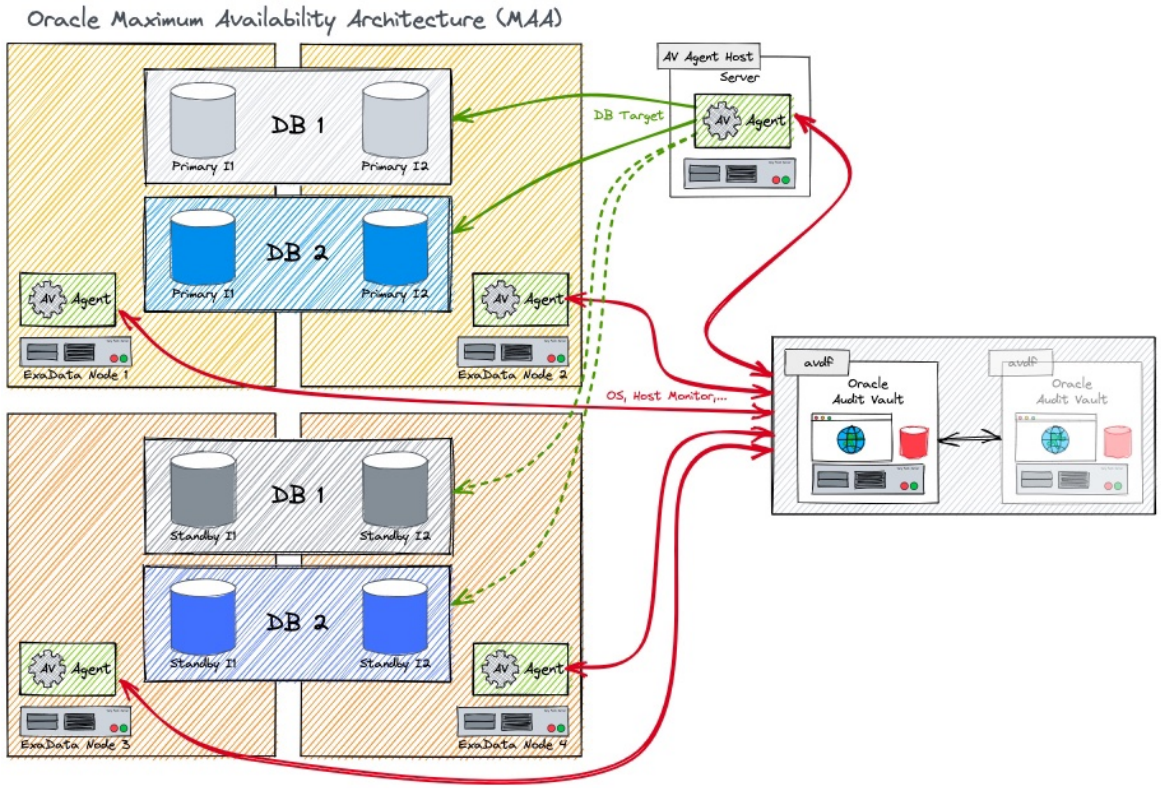
- Simple **excel spreatsheet** to calculate requirements for *Audit Vault Server, Audit Vault Agents, Database Firewall* storage, CPU and memory reuirements
- Oracle Support Document 2092683.1

High Availability

Oracle AVDF versus Audit Trails

What must be high available?

- **Audit Vault Server** in High Availability Mode
  - Two AV Server paired for business continuity
  - Configured internally as Standby Database
- **Audit Vault Agent**
  - Configured as cluster resource
  - Single point of failure
  - Local buffer in audi trails
- **Audit Trail**
  - Depends on trail type e.g. Database, OS, RAC, DataGuard,…
  - Will keep audit data until it is processed



Is it necessary to keep all components high available?

6

Licensing

How much does it cost?

Licensing

Licensing model for Oracle Audit Vault and Database Firewall

One License to rule them all. i.h., Oracle AVDF license covers

- *Audit Vault Server* and *Database Firewall*
- *Audit Vault Agents* with plug-ins as well Host Monitor
- *Enterprise Manager* plug-in for *Oracle Audit Vault and Database Firewall*
- Special-Use licensing covers also all stacked software application

Licensing for *Oracle Audit Vault and Database* Firewall is based on:

- The targets being monitored
- The number of processors on the computers where the targets are located
- The number of named users of those targets

Unrestricted use could become expensive

7

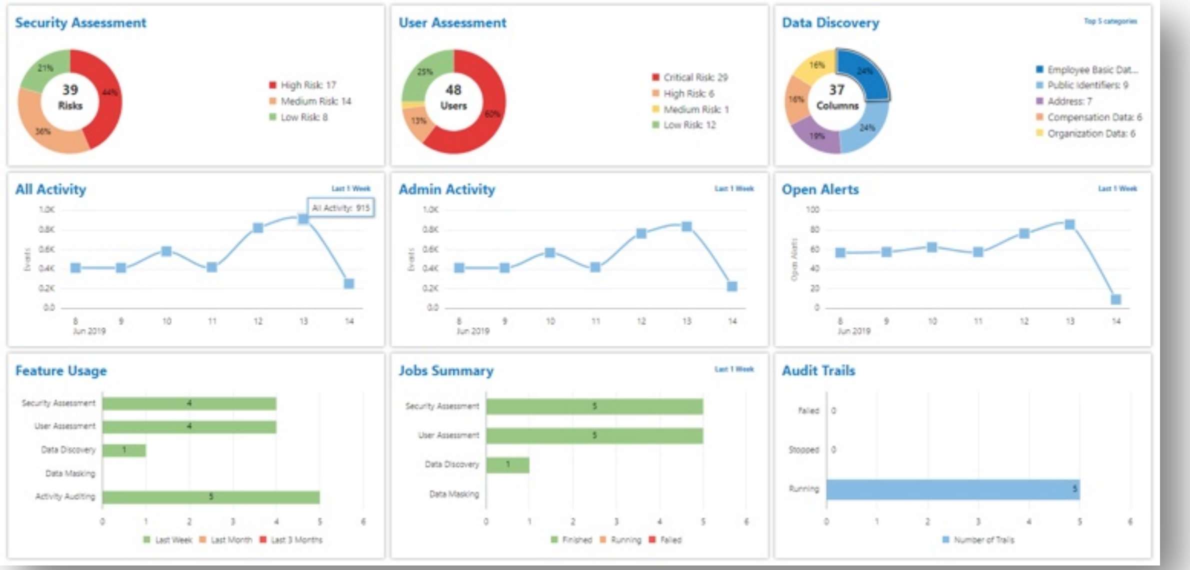
Other Solutions

Alternative Solutions
and Products

Oracle Data Safe

Cloud based Database Security Service

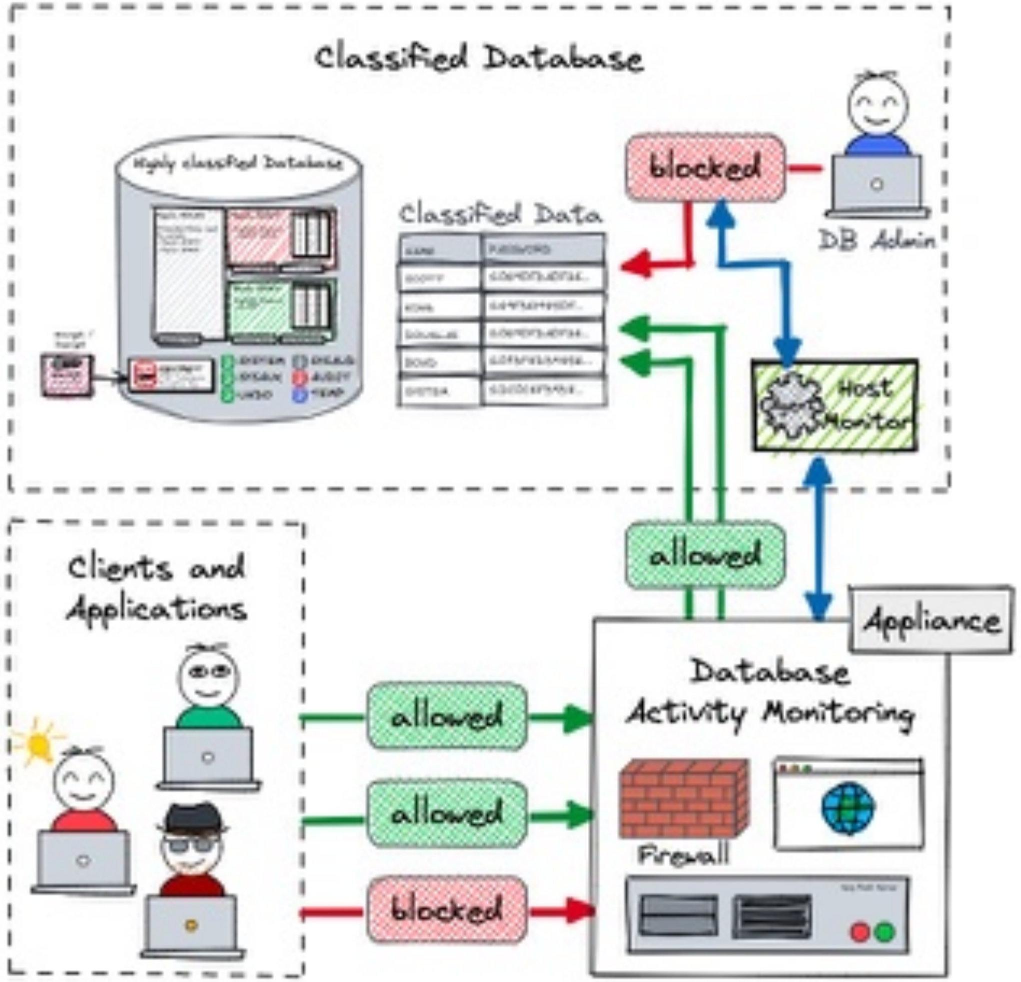
- **Security Assessment** to assess the security of database configurations
- **User Assessment** to assess the security of database users and identify high risk users
- **Data Discovery** to identify sensitive data in databases
- **Data Masking** provides a way to mask sensitive data so that the data is safe for non-production purposes
- **Activity Auditing** lets audit user activity on databases so one can monitor database usage
- **Alerts** keep one informed
- Available for cloud and on-premises databases



Source: https://blogs.oracle.com

Database Activity Monitoring

Control what happens within the databases



- **Similar** functionality to the database firewall
- inspect SQL **Traffic** to Database
- Monitor local activity with **Host Monitor**
- Multi Database Support
- Limitation in SQL Net Traffic encryption
- No Oracle Audit integration

Third party products like

- Imperva **SecureSphere** Data Security
- IBM Security **Guardium**
- Sentrigo Hedgehog aka McAfee DAM aka …

Custom Solutions

What ever you like to build…

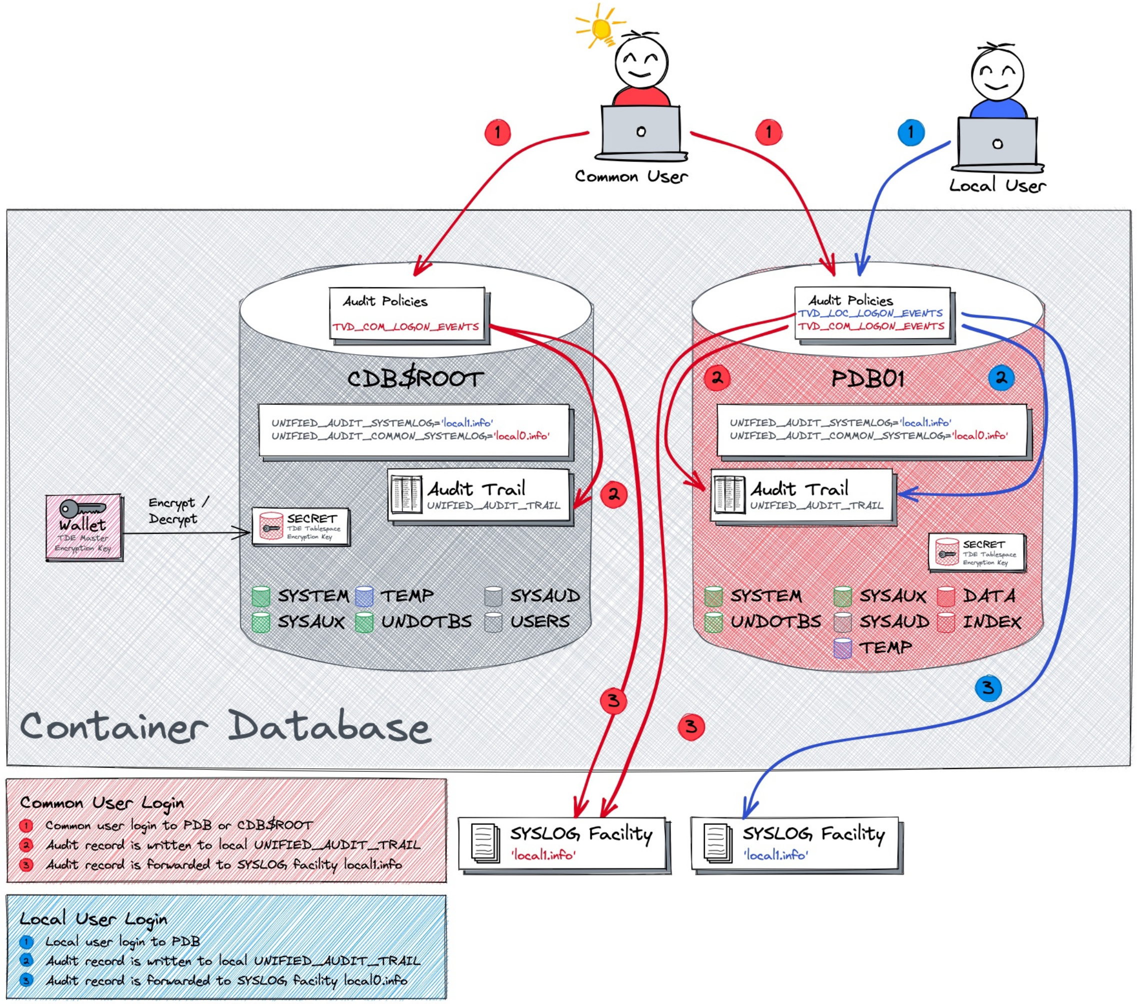
The solutions are usually **limited** to…

- Central Repository
- Reporting
- SOC (Security Operation Center) Integration

Possible Solution Approaches

- **Splunk** Audit data Collection
- **Elasticsearch** or ELK Stack
- **SYSLOG** integration

Usually **no** Audit Policy Management and Database Security Assessment



UNIFIED_AUDIT_SYSTEMLOG='local1.info'
UNIFIED_AUDIT_COMMON_SYSTEMLOG='local0.info'

UNIFIED_AUDIT_SYSTEMLOG='local1.info'
UNIFIED_AUDIT_COMMON_SYSTEMLOG='local0.info'

Common User Login

1. Common user login to PDB or CDB$ROOT
2. Audit record is written to local UNIFIED_AUDIT_TRAIL
3. Audit record is forwarded to SYSLOG facility local1.info

Local User Login

1. Local user login to PDB
2. Audit record is written to local UNIFIED_AUDIT_TRAIL
3. Audit record is forwarded to SYSLOG facility local0.info

8

Conclusion

Is AVDF a Product for your Database Environment?

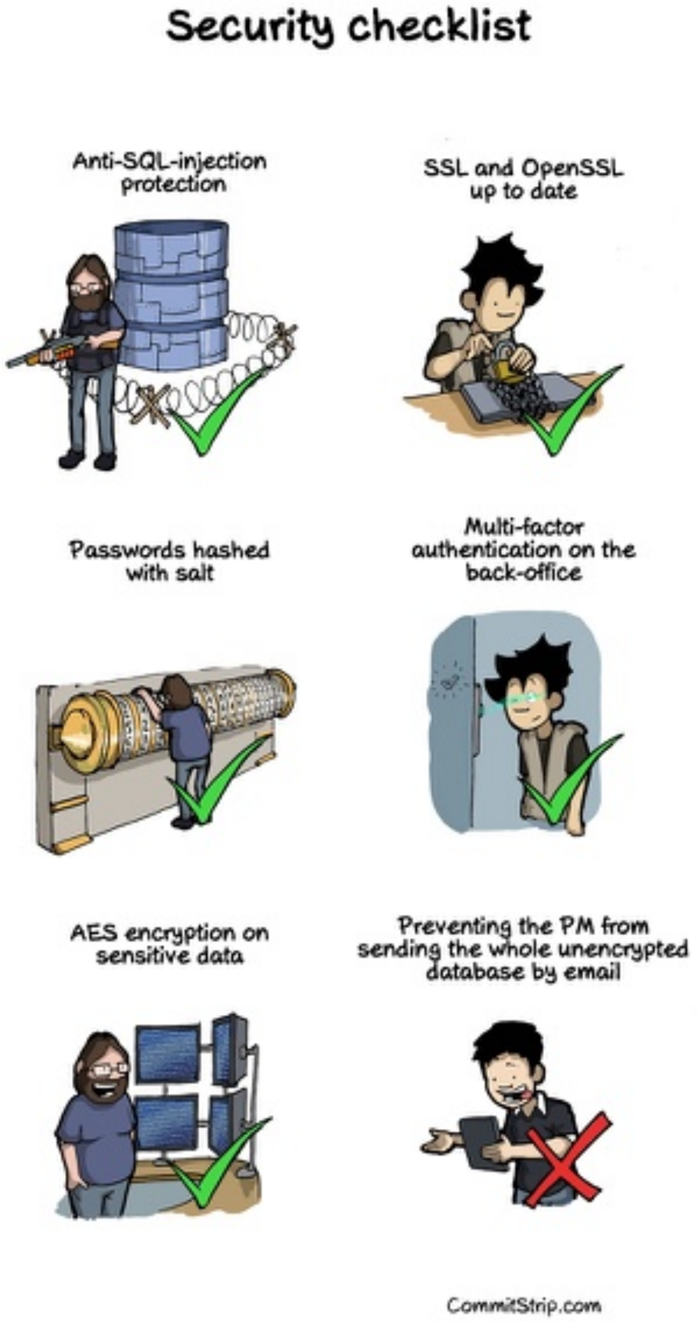
Conclusion

Is AVDF a Product for your Database Environment?

- *Oracle Audit Vault and Database Firewall* has **grown up**
- Regular **release updates** as of major release Oracle AVDF 20

Two major **challenges** remain:

- **Operation** of a software appliance
  - Perfect for none DBA based operation
  - Not everything is reasonable/possible
- (Storage) **Space**: the final frontier
  - **too much** audit data makes handling sluggish
  - **SAN / iSCSI repository** extends the storage boundaries
  - Appropriate **retention intervals** are a prerequisite


Security checklist
Anti-SQL-injection protection
SSL and OpenSSL up to date
Passwords hashed with salt
Multi-factor authentication on the back-office
AES encryption on sensitive data
Preventing the PM from sending the whole unencrypted database by email
CommitStrip.com

The main challenge is still the security concept of the databases.

Thank You

Oracle AVDF Sources

Documentation, White Papers, Support Notes and other Links

- Oracle Audit Vault and Database Firewall online documentation
- Oracle Database Unified Audit Best Practice Guidelines
- 1681969.2 Oracle Audit Vault and Database Firewall
- 1328209.1 Oracle AVDF (Audit Vault and Database Firewall) Releases Support Status
- 2092683.1 Audit Vault and Database Firewall Best Practices and Sizing Calculator for AVDF 12.2 and AVDF 20
- 2725072.1 How to Deploy Audit Vault & Database Firewall (AVDF) In OCI?