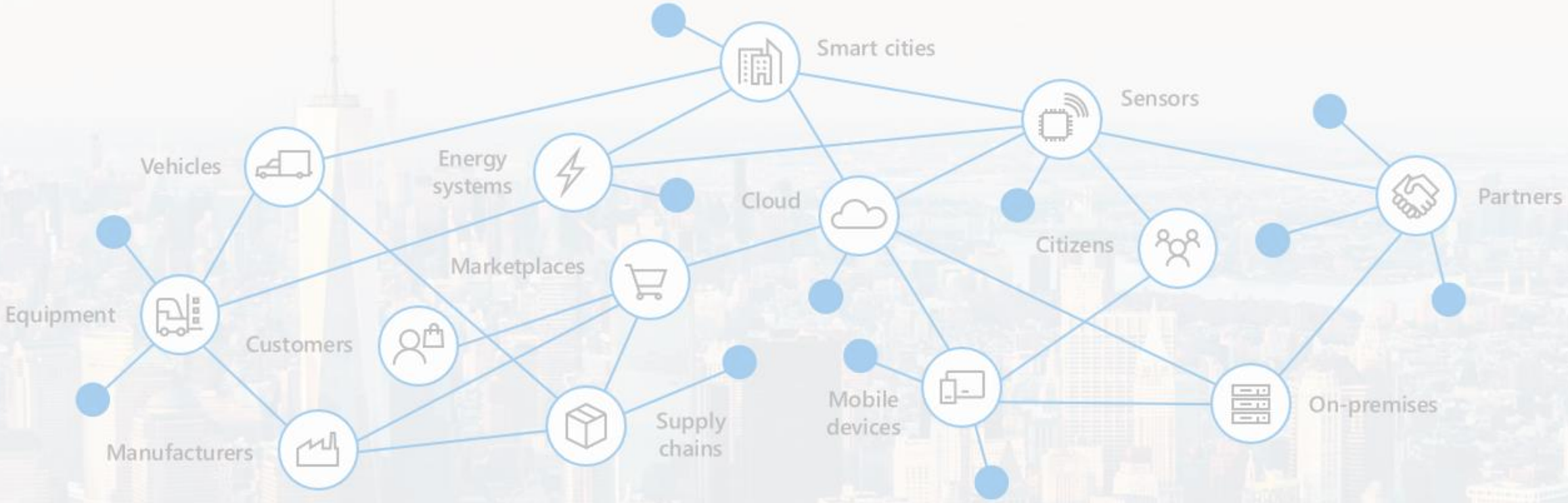
Microsoft

2020.06.18

Azure Data Security



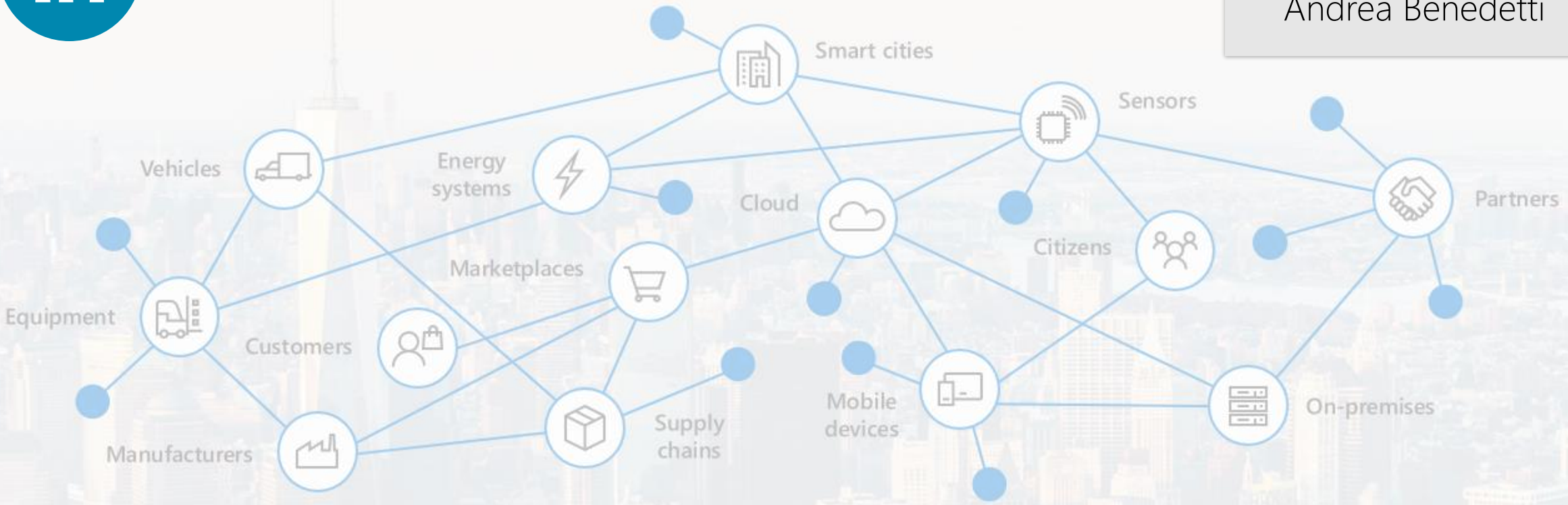
Andrea Benedetti
Sr. Cloud Solution Architect | Data & AI Engineer

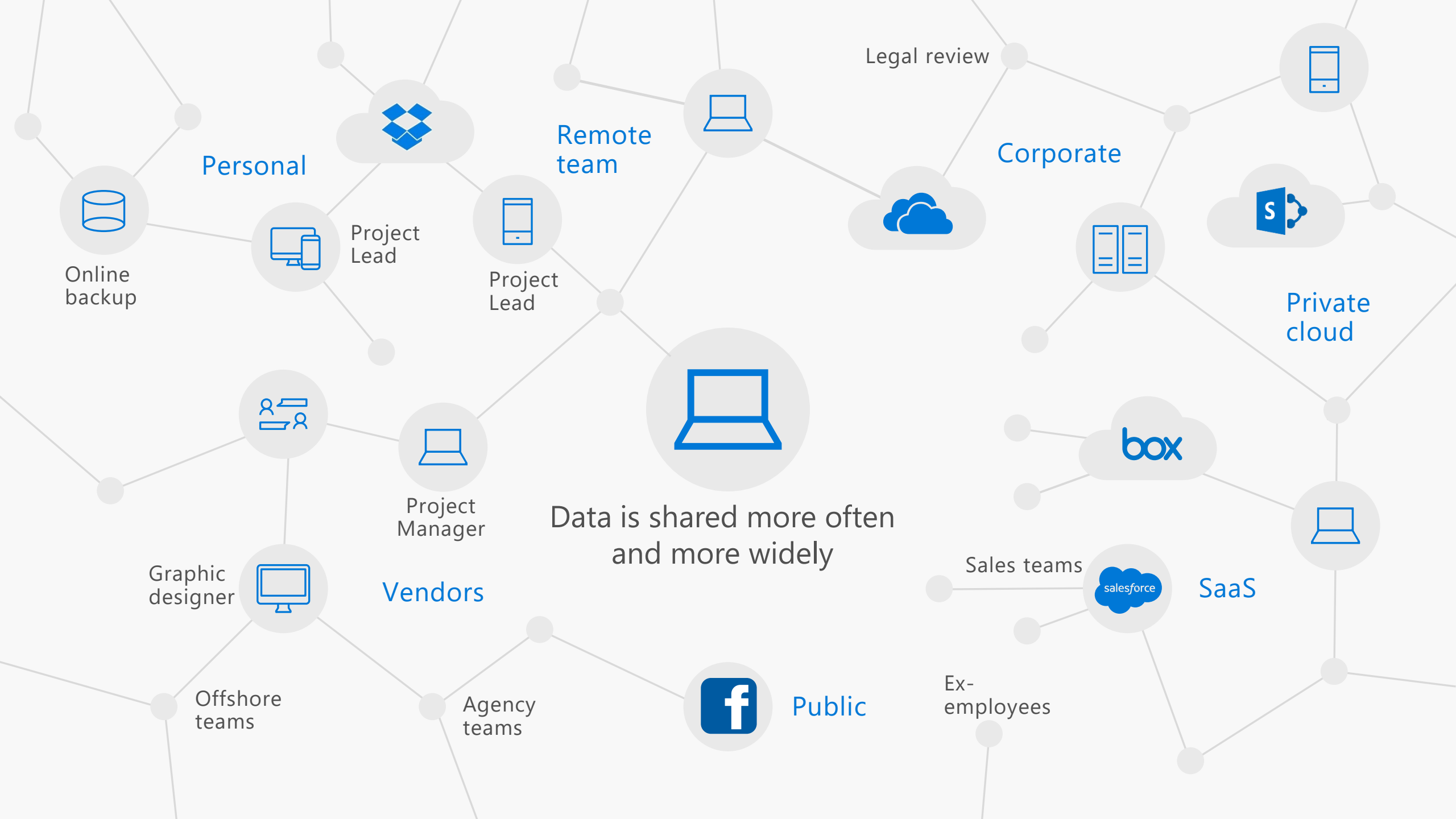
https://twitter.com/anBenedetti

https://github.com/anbened

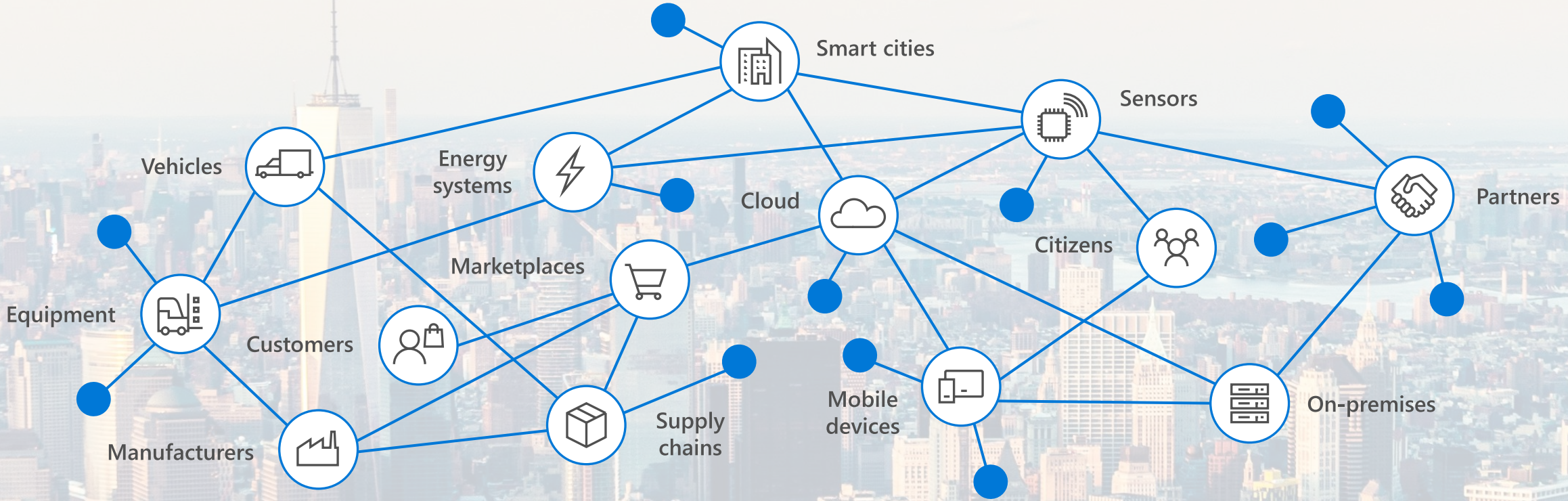
https://www.linkedin.com/in/abenedetti/

Andrea Benedetti




Legal review
Personal
Remote team
Corporate
Online backup
Project Lead
Project Lead
Private cloud
Project Manager
Data is shared more often and more widely
box
Graphic designer
Vendors
Sales teams
salesforce
SaaS
Offshore teams
Agency teams
Public
Ex-employees

Data is exploding across the digital estate



Hundreds of compliance controls
Hundreds of vendors

Strategies for success

Challenges

163 zettabytes of data a year will be created by 2025

Adopt a comprehensive information governance strategy

Data is your biggest risk

Protect information where it goes

200+ updates per day from 750 regulatory bodies

Leverage the shared responsibility model

Cost of compliance continues to increase year over year

Use integrated tools that span end to end scenarios

Source: Global Security Intelligence Report

The Microsoft solution

Assess

Manage your compliance from one place with actionable insights & simplification

Azure Data Catalog
SQL Query Language
SQL Vulnerability Assessment

Protect

Automatically protect and govern sensitive data across devices, apps and cloud services

Data Discovery and Classification
Always Encrypted
Always On Availability
Azure SQL Threat Protection
Dynamic Data Masking
Row-level Security
Azure Security Center

Respond

Efficiently respond to regulatory requests by leveraging AI to find the most relevant data

SQL Server Audit

Enterprise grade security that is easy-to-use

Defense-in-depth

Security Management

- Vulnerability Assessment

Threat Protection

- SQL Threat Detection
- SQL Auditing

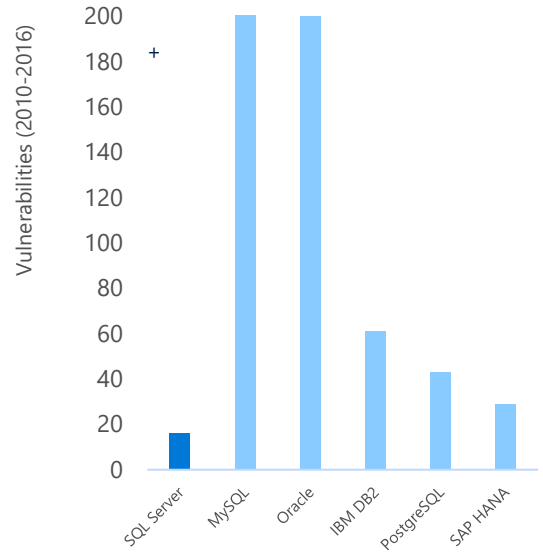
Identity & Access Management

- SQL Permissions
- VNET
- SQL Firewall (server- and database-level)
- SQL Authentication
- Azure Active Directory Authentication (w/ MFA)
- Row-level security

Information Protection

- Encryption-in-flight (Transport Layer Security TLS over TDS)
- Encryption-at-rest (Transparent Data Encryption TDE)
  - *Service- or User-managed keys*
  - *Backup encryption*
- Encryption-in-use (Always Encrypted)
- Data Masking
- Data Discovery and Classification

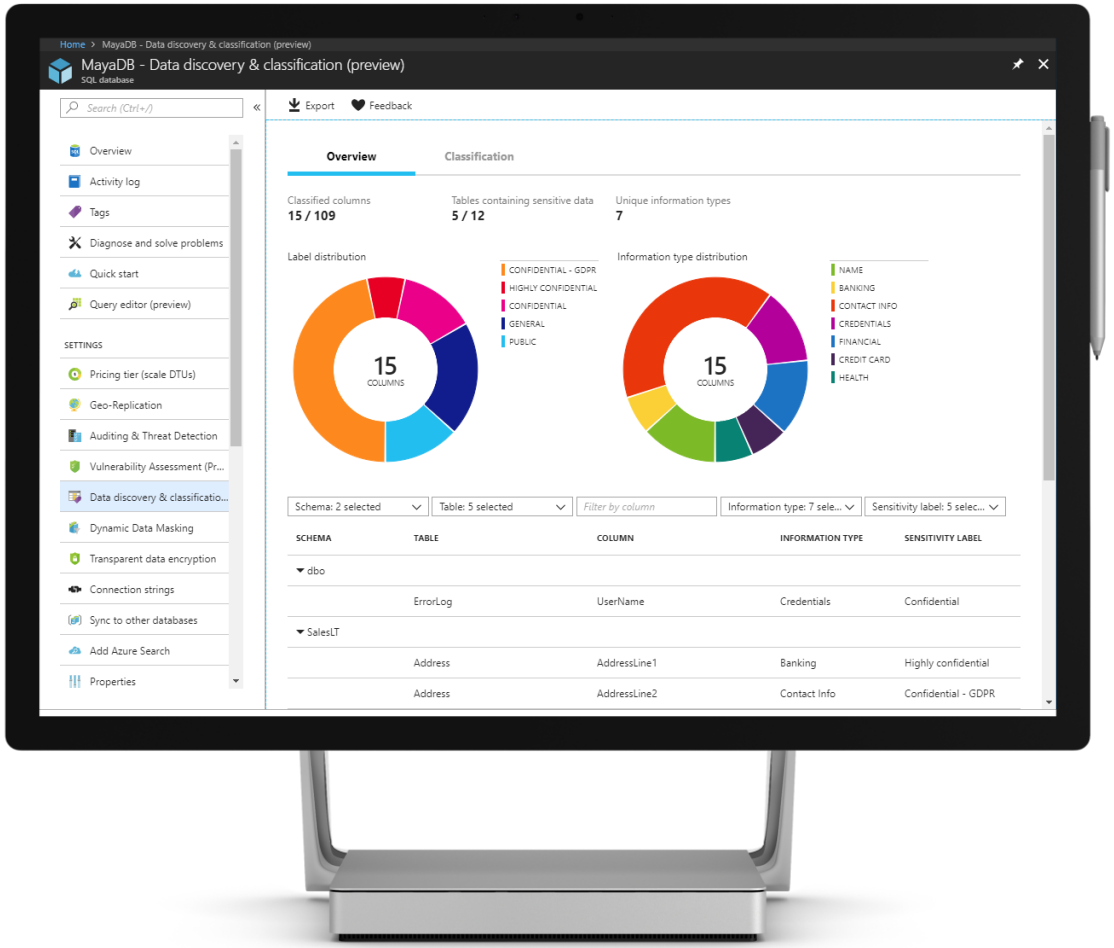
Trusted: most secure over last 7 years



Discover and classify personal data

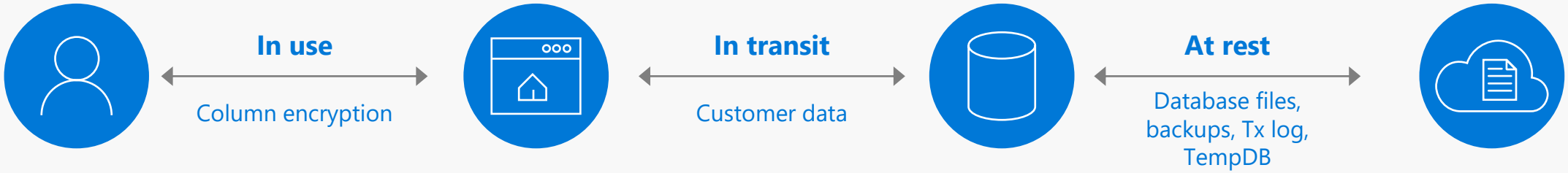
- Data Discovery & Classification forms a new SQL Information Protection paradigm to protect data
- Discovery & Classification recommendations engine scans database and identifies columns containing potentially sensitive data
- Sensitivity classification labels can be tagged on columns for advanced auditing and protection
- Query result set sensitivity is calculated in real time for auditing
- The database classification state can be viewed in a detailed dashboard or an Excel report

Dashboard of a sample database's current classification state



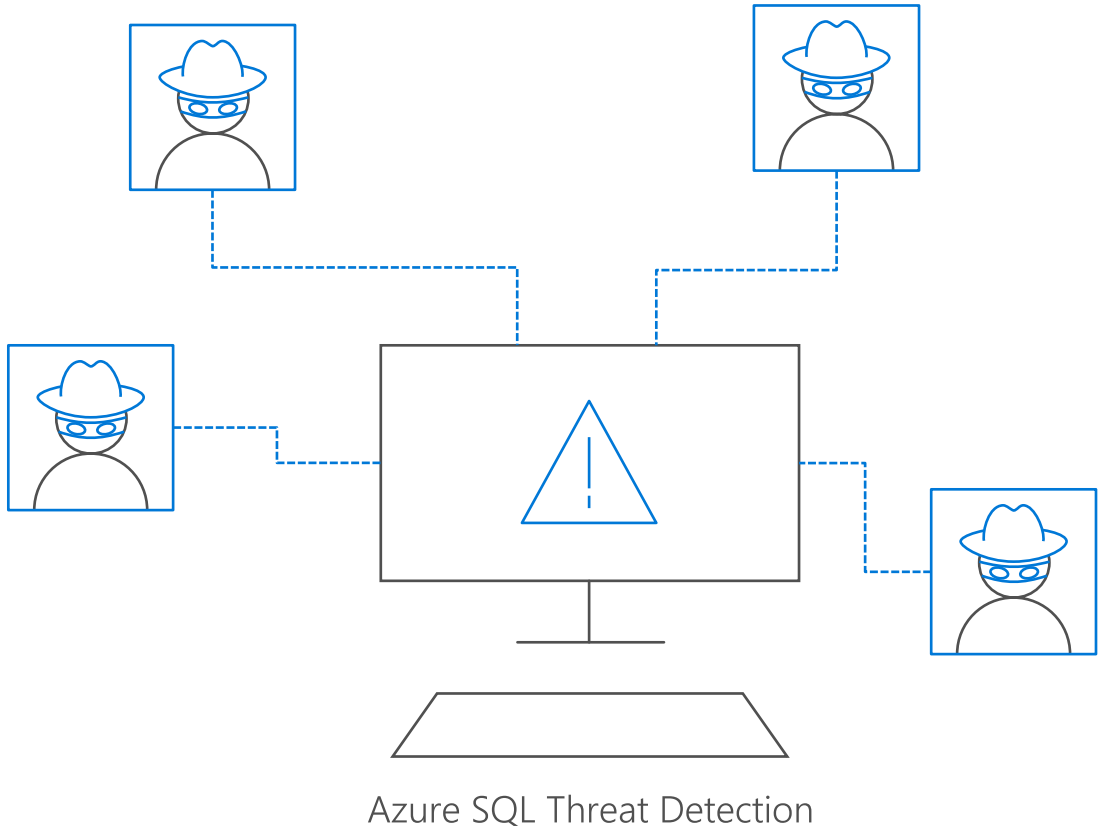
Types of data encryption

Data encryption	Encryption technology	Customer value
In transit	Transport Layer Security (TLS) from the client to the server	Protects data between client and server against snooping and man-in-the-middle attacks *Azure SQL Database is phasing out Secure Sockets Layer (SSL) 3.0 and TLS 1.0 in favor of TLS 1.2
At rest	Transparent Data Encryption (TDE) for Azure SQL Database	Protects data on the disk Key management is done by Azure, which makes it easier to obtain compliance
In use (end-to-end)	Always Encrypted for client-side column encryption	Data is protected end-to-end, but the application is aware of encrypted columns This is used in the absence of data masking and TDE for compliance-related scenarios



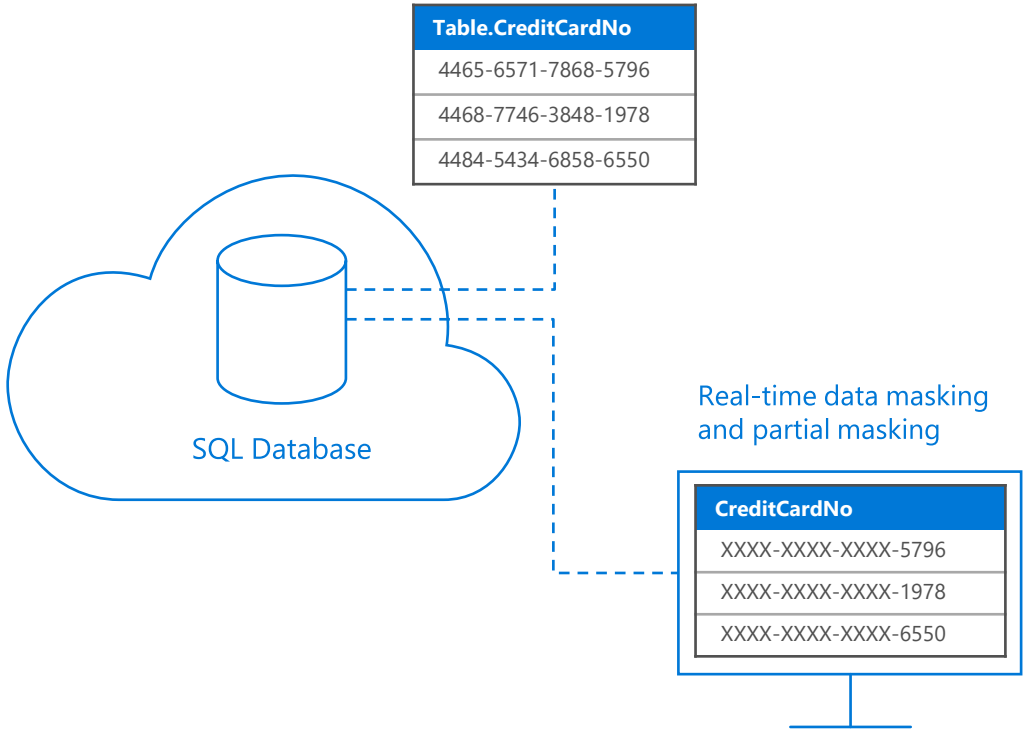
Detect unusual activity with Azure SQL Threat Detection

- Azure SQL Threat Detection discovers and identifies anomalous activities
- Users receive alerts upon suspicious database activities, potential vulnerabilities, and SQL injection attacks
- Recommended actions how on to investigate and mitigate threats follow alerts



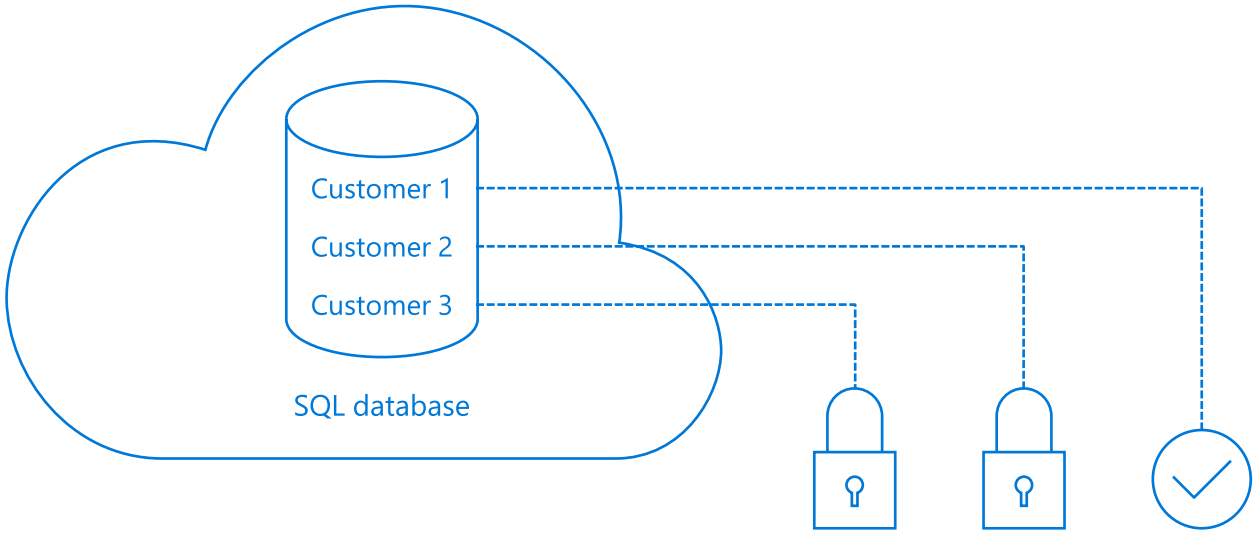
Control sensitive data access with Dynamic Data Masking

- Non-privileged users cannot see sensitive data
- Apply data masking in real-time to query results based on security policy
- Available in the Azure portal and also via T-SQL

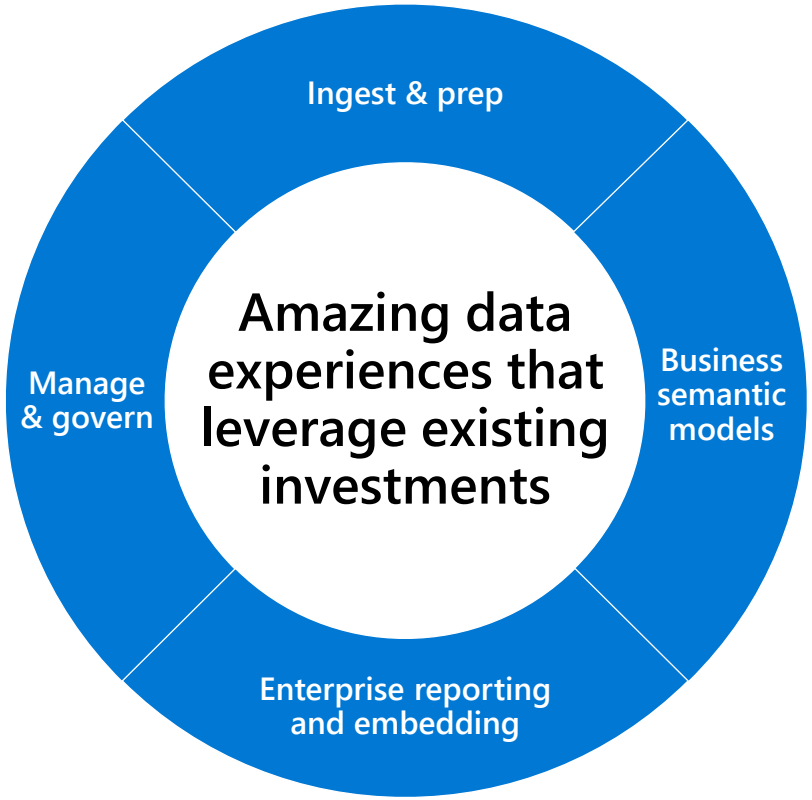


Manage data access with Row-Level Security

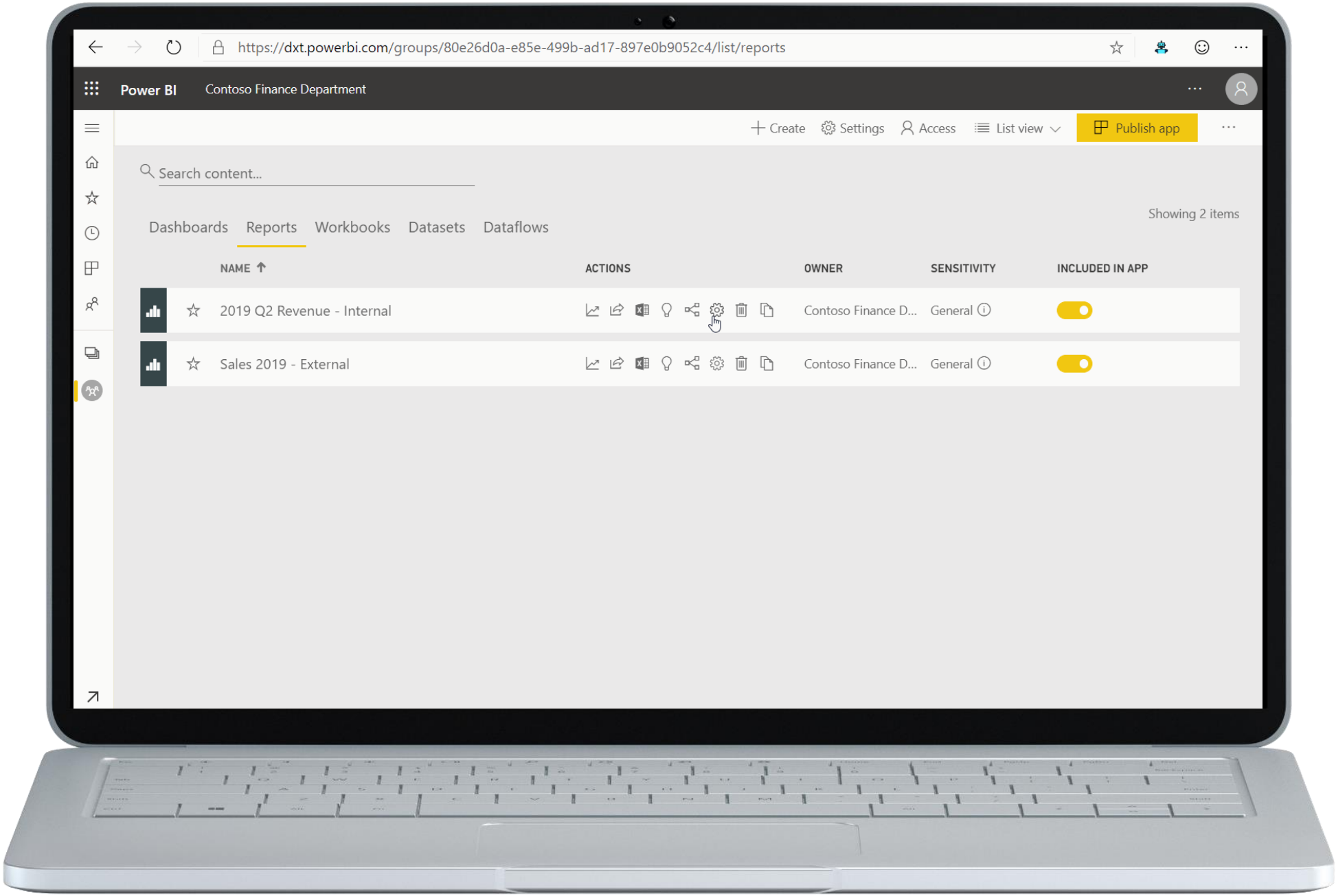
- Fine-grained access control over specific rows in a database
- Prevent unauthorized access when filtering in multitenant applications
- Enforcement logic inside the database and schema bound to the table
- Centralize Row-Level access logic within the database
- Provide better support services preventing your representative from getting access to customer's sensitive data



Data culture is about everyone

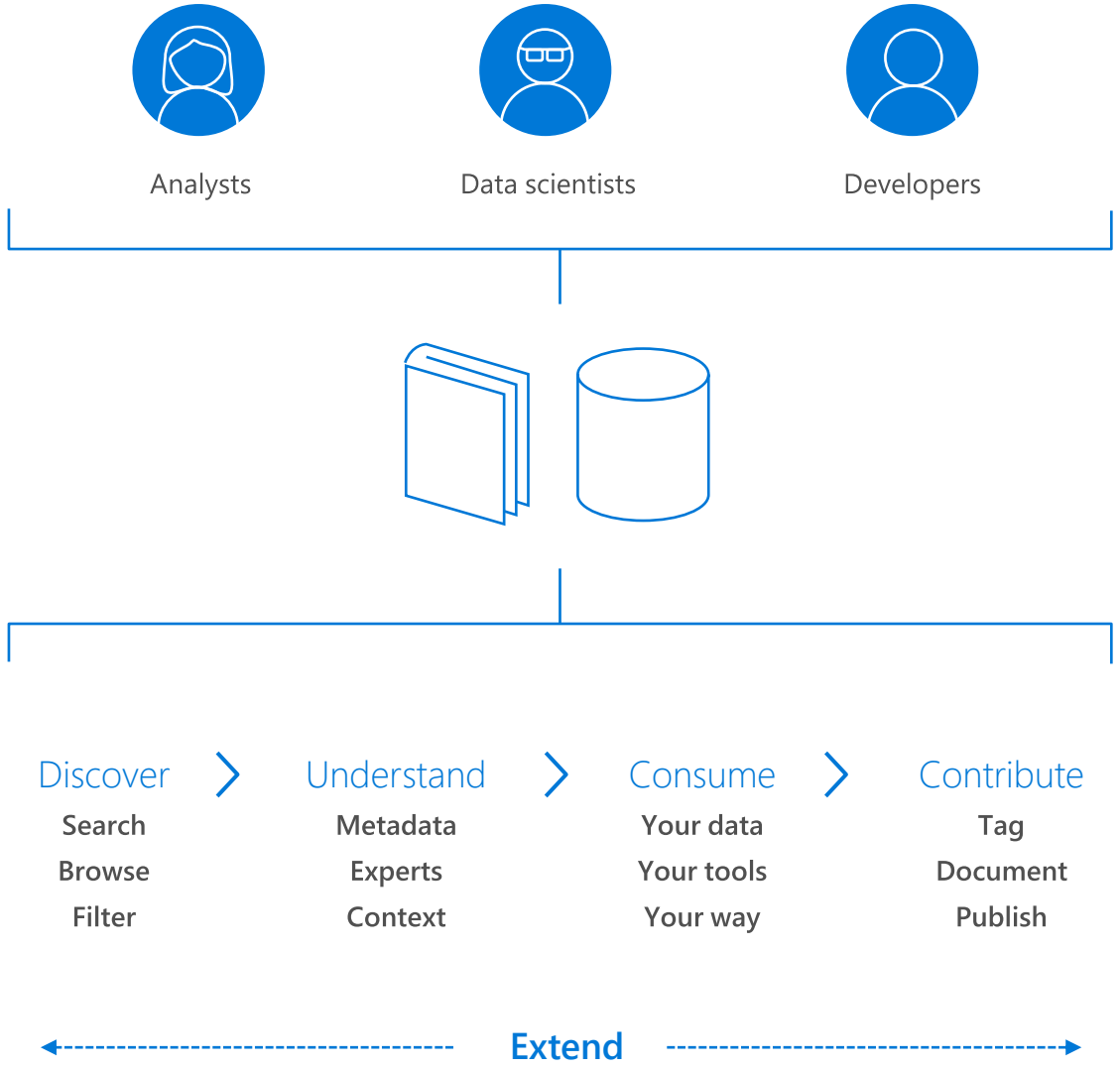


Protect data with Microsoft Information Protection



Simplify data discovery with Azure Data Catalog

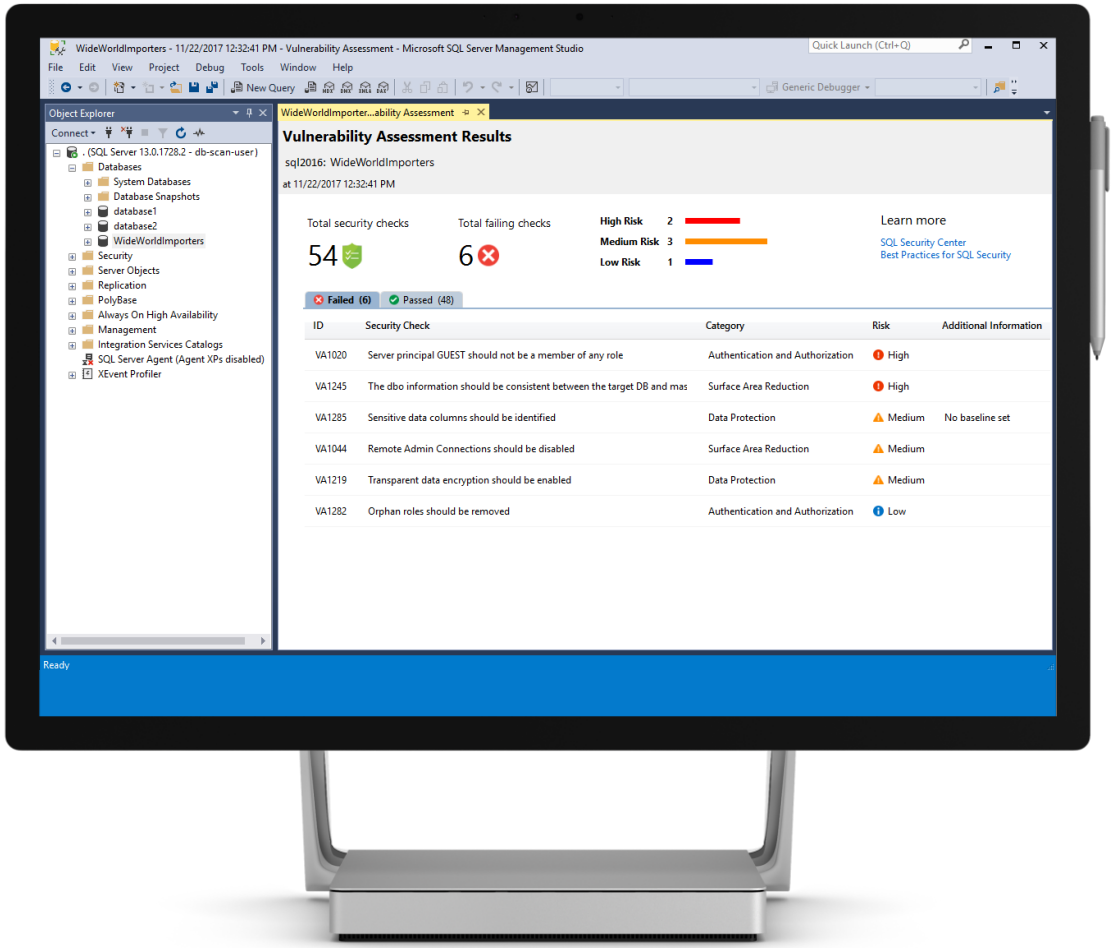
- Find the data you need and use it with your tools in an intuitive user experience
- Understand the usage and intent of new data sources for continuous value creation
- Democratize data discovery and spend less time looking for data
- New features including support for Azure Active Directory service principals and authentication, and support for linking directly to specific business glossary terms



Know your security state with SQL Vulnerability Assessment

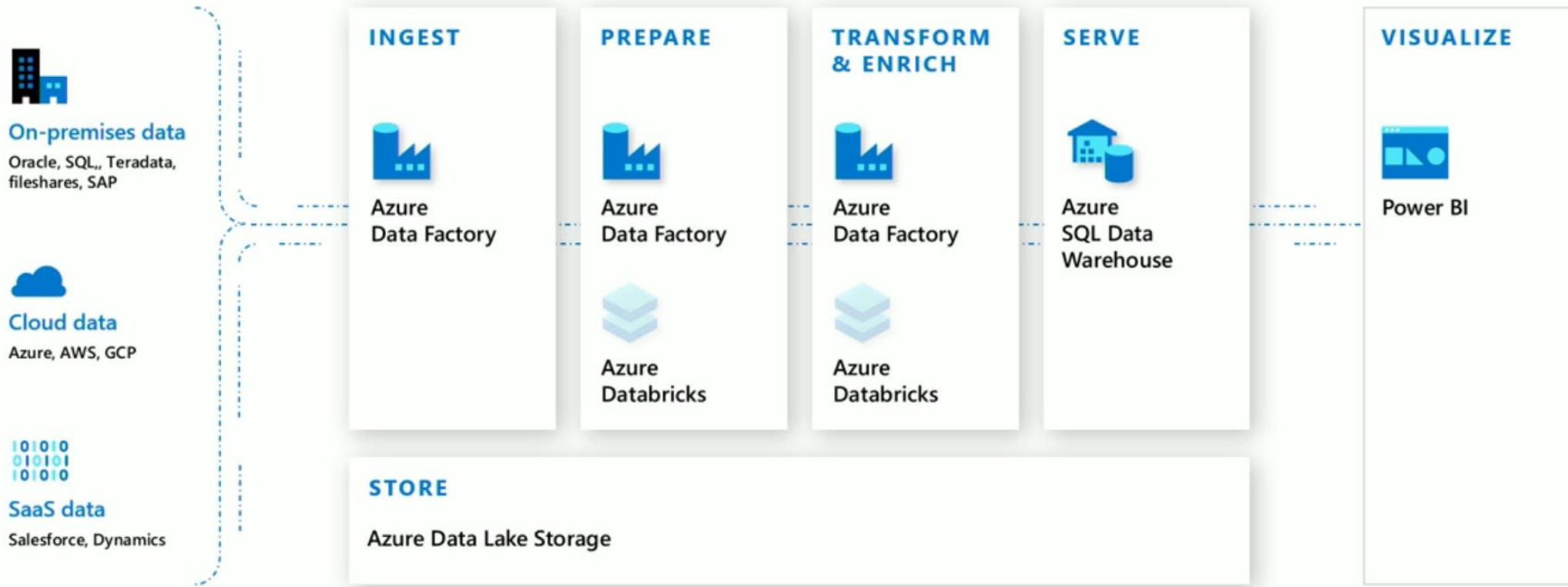
- Meet compliance requirements that require database scan reports
- Meet security standards of GDPR
- Monitor a dynamic database environment where changes are difficult to track
- Drill-down on assessment results to understand the impacts of findings and use actionable remediation information to resolve issues

Sample Vulnerability Assessment report viewed in SQL Server Management Studio




Azure Synapse Analytics

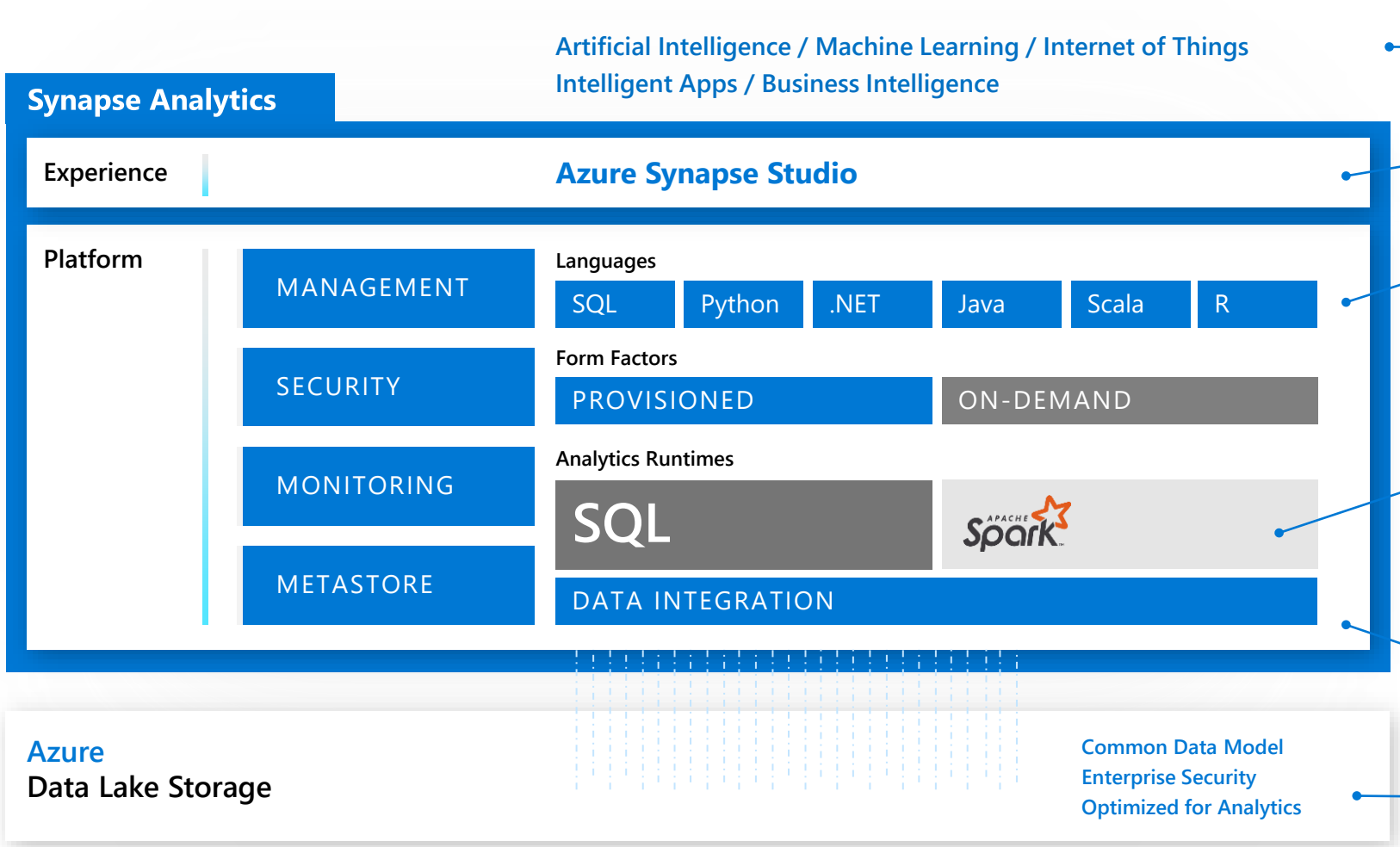
Modern Data Warehouse



Azure Synapse Analytics - *Data Lakehouse*

Azure Synapse Analytics

Integrated data platform for BI, AI and continuous intelligence



Designed for analytics **workloads at any scale**

SaaS **developer experiences** for code free and code first

Multiple **languages** suited to different analytics workloads

Integrated analytics runtimes available provisioned and serverless on-demand

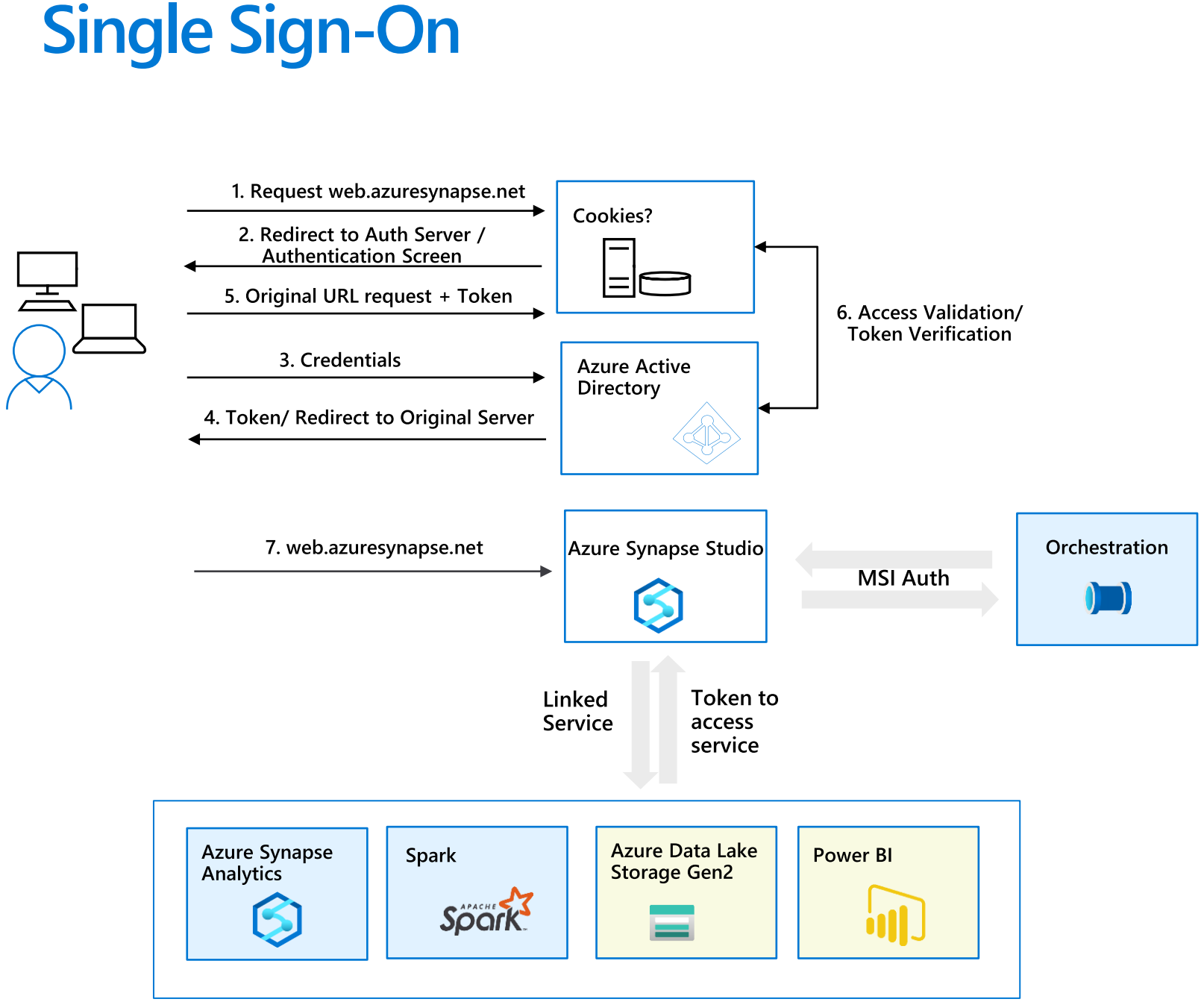
SQL Analytics offering T-SQL for batch, streaming and interactive processing

Spark for big data processing with Python, Scala, R and .NET

Integrated **platform services** for, management, security, monitoring, and metastore

Data **lake integrated** and Common Data Model aware

Single Sign-On



Implicit authentication - User provides login credentials once to access Azure Synapse Workspace

AAD authentication - Azure Synapse Studio will request token to access each linked services as user. A separate token is acquired for each of the below services:

1. ADLS Gen2
2. Azure Synapse Analytics
3. Power BI
4. Spark – Spark Livy API
5. management.azure.com – resource provisioning
6. Develop artifacts – dev.workspace.net
7. Graph endpoints

MSI authentication - Orchestration uses MSI auth for automation

Industry-leading security and compliance

Enterprise-grade security

Industry-leading compliance

ISO 27001

SOC 1 Type 2

SOC 2 Type 2

PCI DSS Level 1

Cloud Controls Matrix

ISO 27018

Content Delivery and Security Association

Shared Assessments

FedRAMP JAB P-ATO

HIPAA / HITECH

FIPS 140-2

21 CFR Part 11

FERPA

DISA Level 2

CJIS

IRS 1075

ITAR-ready

Section 508 VPAT

European Union Model Clauses

EU Safe Harbor

United Kingdom G-Cloud

China Multi Layer Protection Scheme

China GB 18030

China CCCPPF

Singapore MTCS Level 3

Australian Signals Directorate

New Zealand GCIO

Japan Financial Services

ENISA IAF

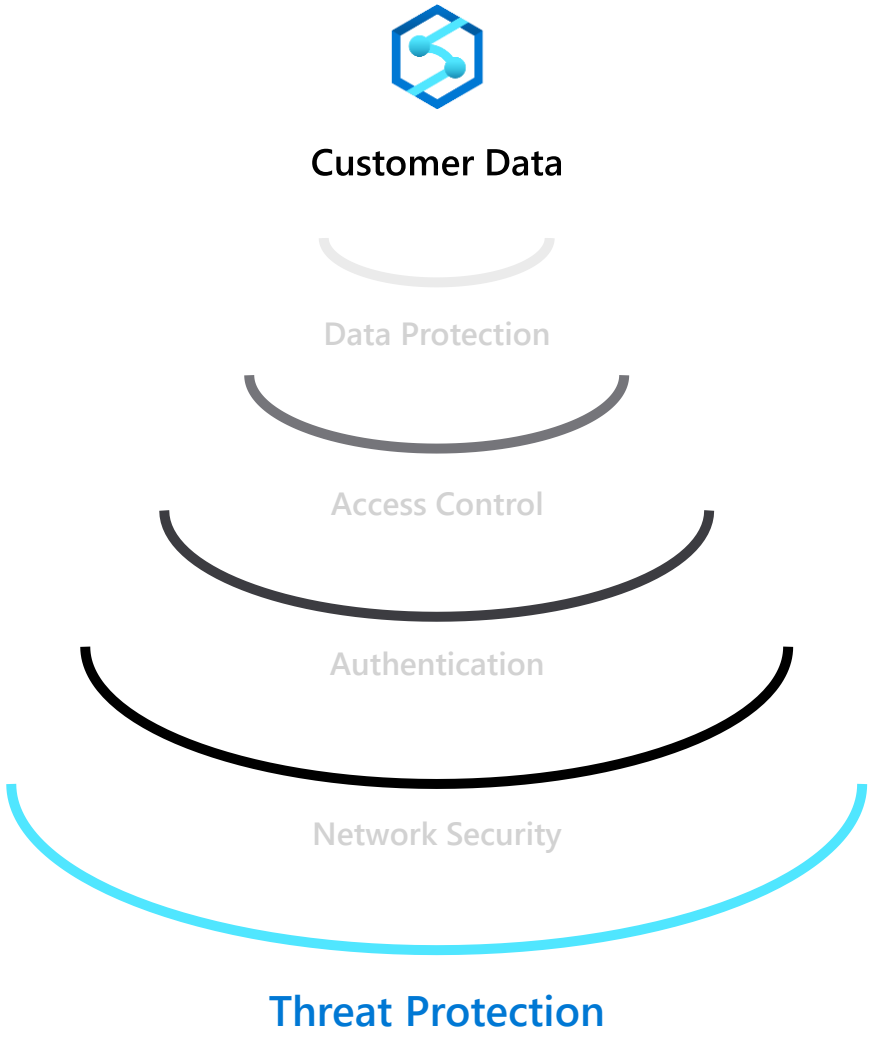
Threat Protection - Business requirements

How do we enumerate and track potential SQL vulnerabilities?

To mitigate any security misconfigurations before they become a serious issue.

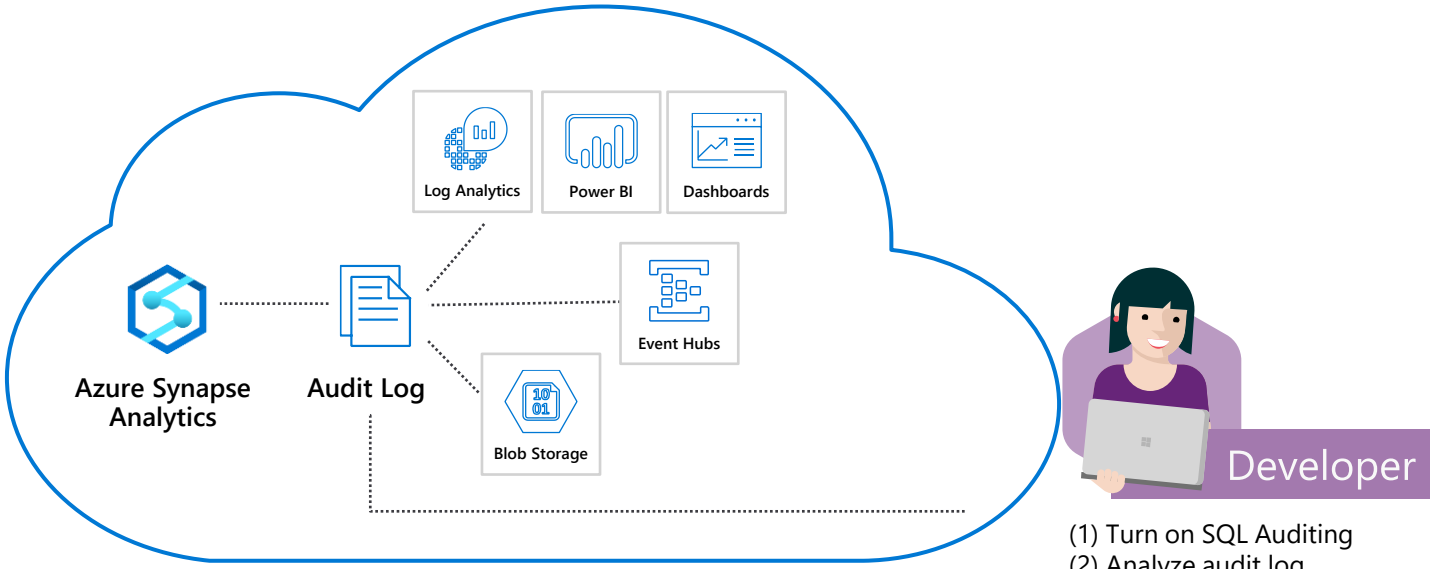
How do we discover and alert on suspicious database activity?

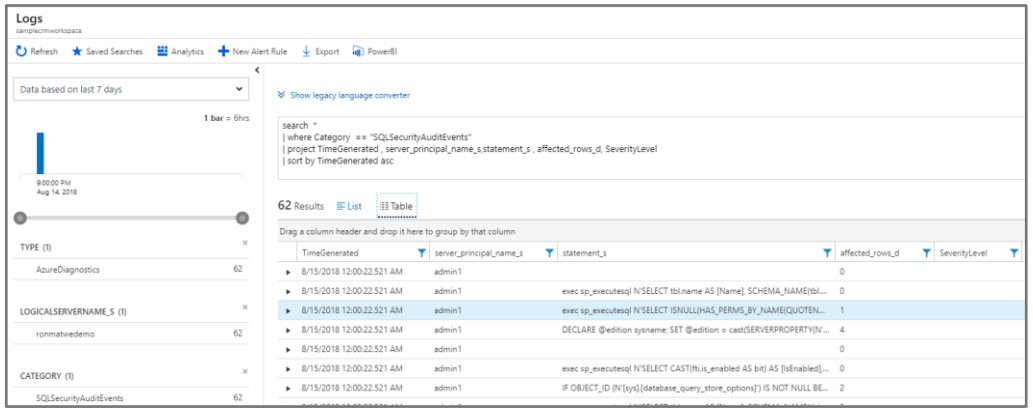
To detect and resolve any data exfiltration or SQL injection attacks.



SQL auditing in Azure Log Analytics and Event Hubs

Gain insight into database audit log

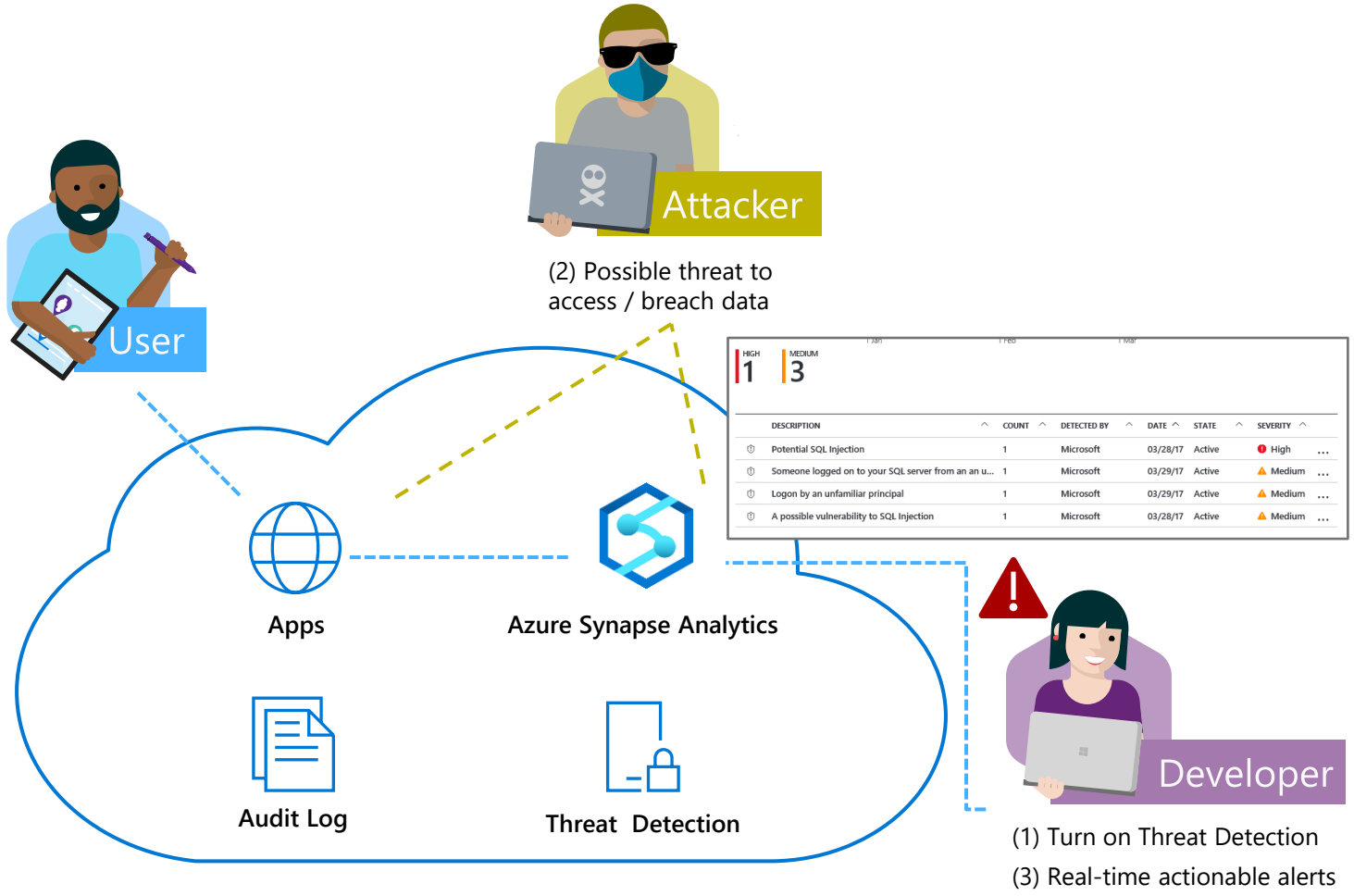




- ✓ **Configurable via audit policy**
- ✓ **SQL audit logs can reside in**
  - Azure Storage account
  - Azure Log Analytics
  - Azure Event Hubs
- ✓ **Rich set of tools for**
  - Investigating security alerts
  - Tracking access to sensitive data

SQL threat detection

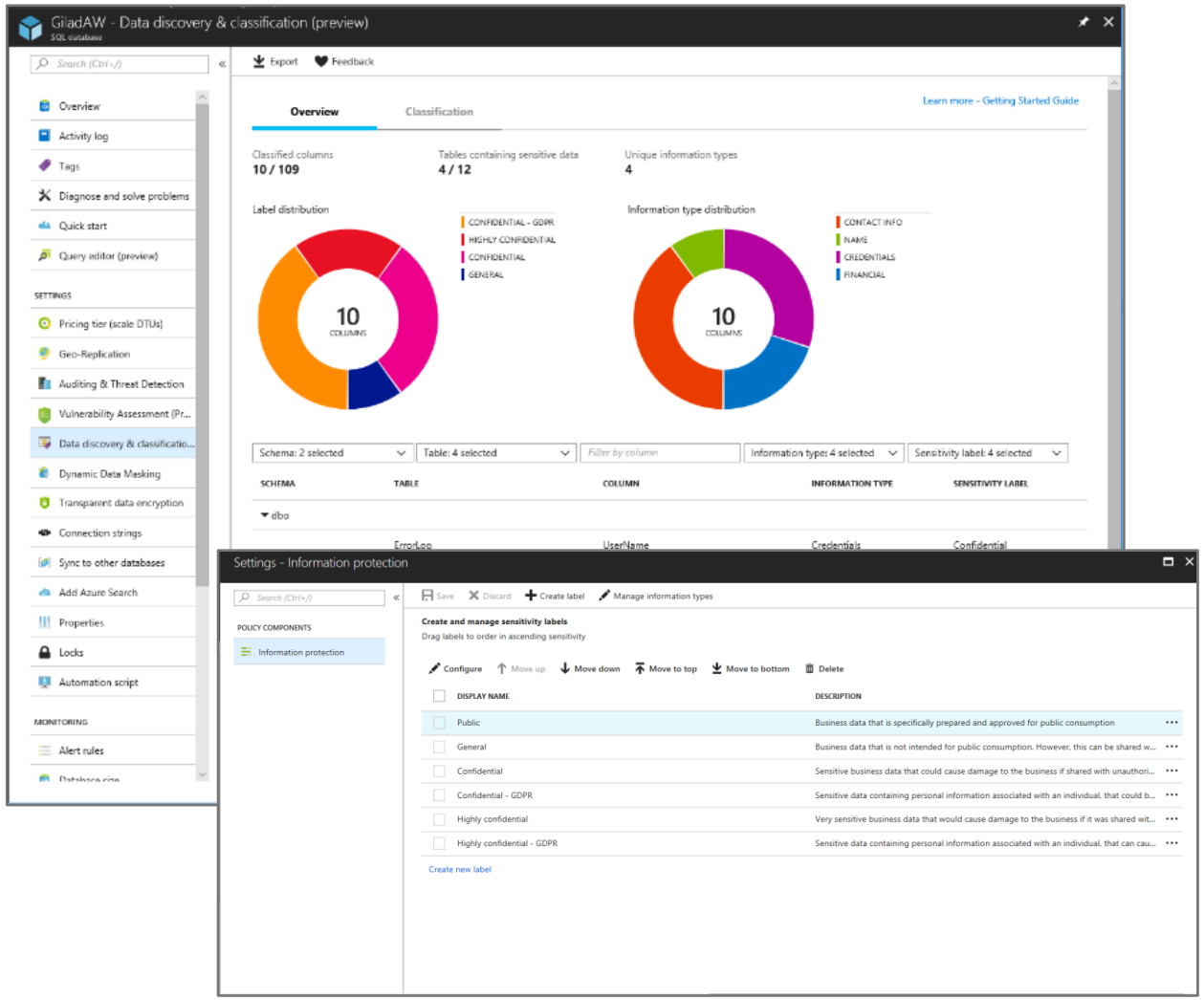
Detect and investigate anomalous database activity



- ✓ Detects potential SQL injection attacks
- ✓ Detects unusual access & data exfiltration activities
- ✓ Actionable alerts to investigate & remediate
- ✓ View alerts for your entire Azure tenant using Azure Security Center

SQL Data Discovery & Classification

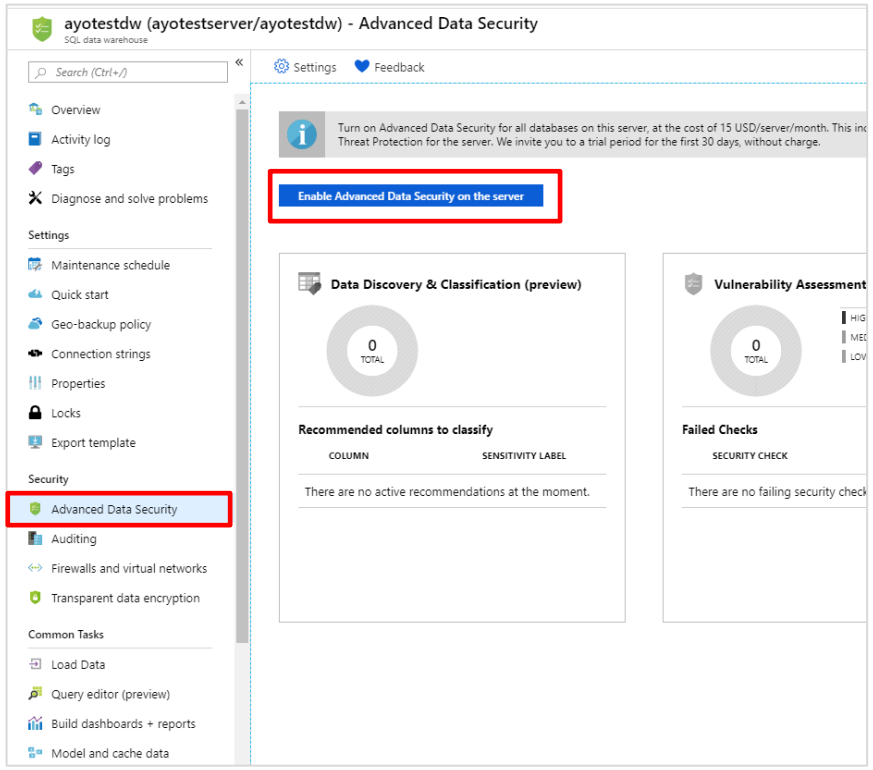
Discover, classify, protect and track access to sensitive data



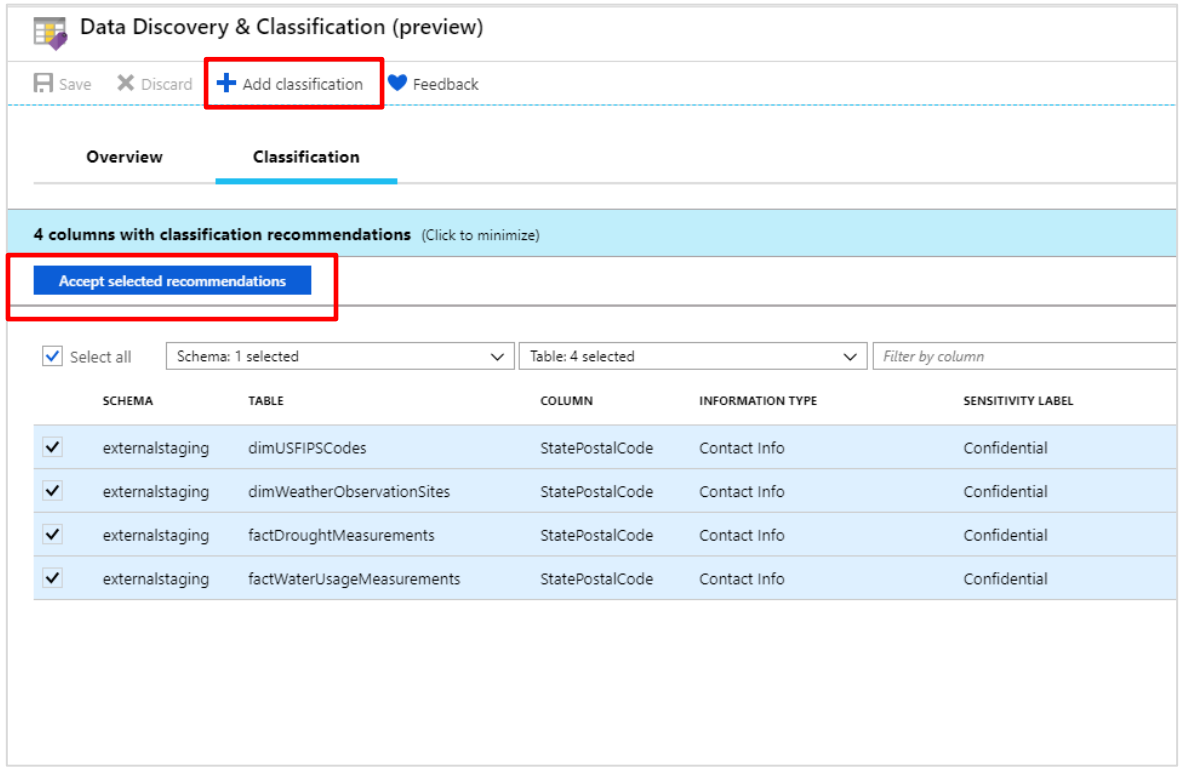
- ✓ Automatic discovery of columns with sensitive data
- ✓ Add persistent sensitive data labels
- ✓ Audit and detect access to the sensitive data
- ✓ Manage labels for your entire Azure tenant using Azure Security Center

SQL Data Discovery & Classification - setup

Step 1: Enable Advanced Data Security on the logical SQL Server

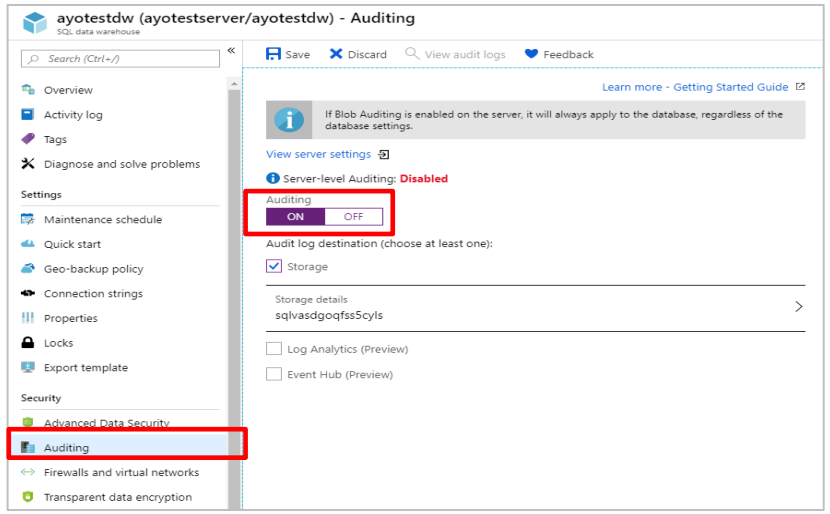


Step 2: Use recommendations and/or manual classification to classify all the sensitive columns in your tables

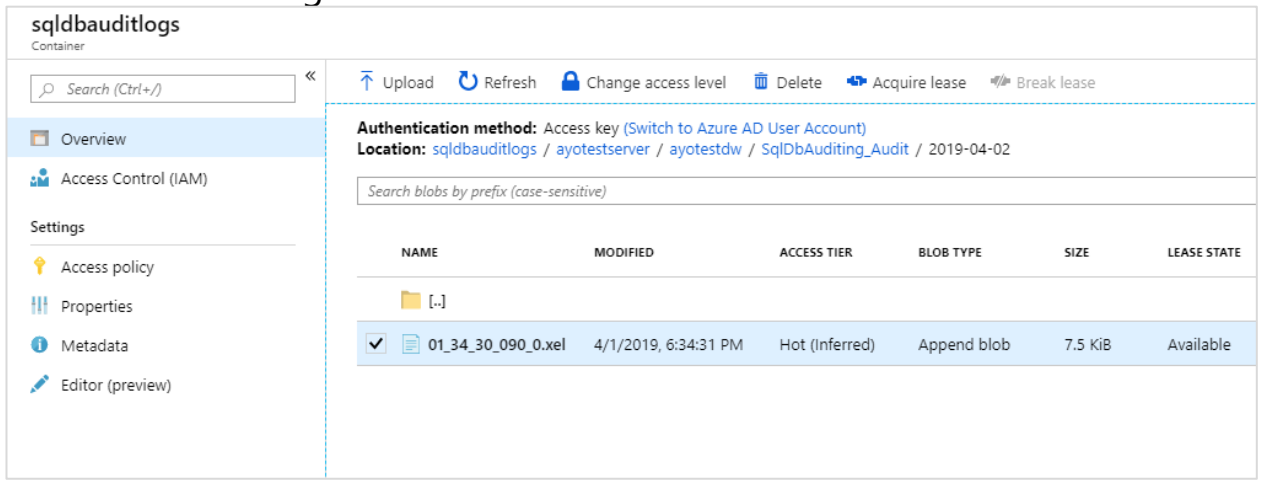


SQL Data Discovery & Classification – audit sensitive data access

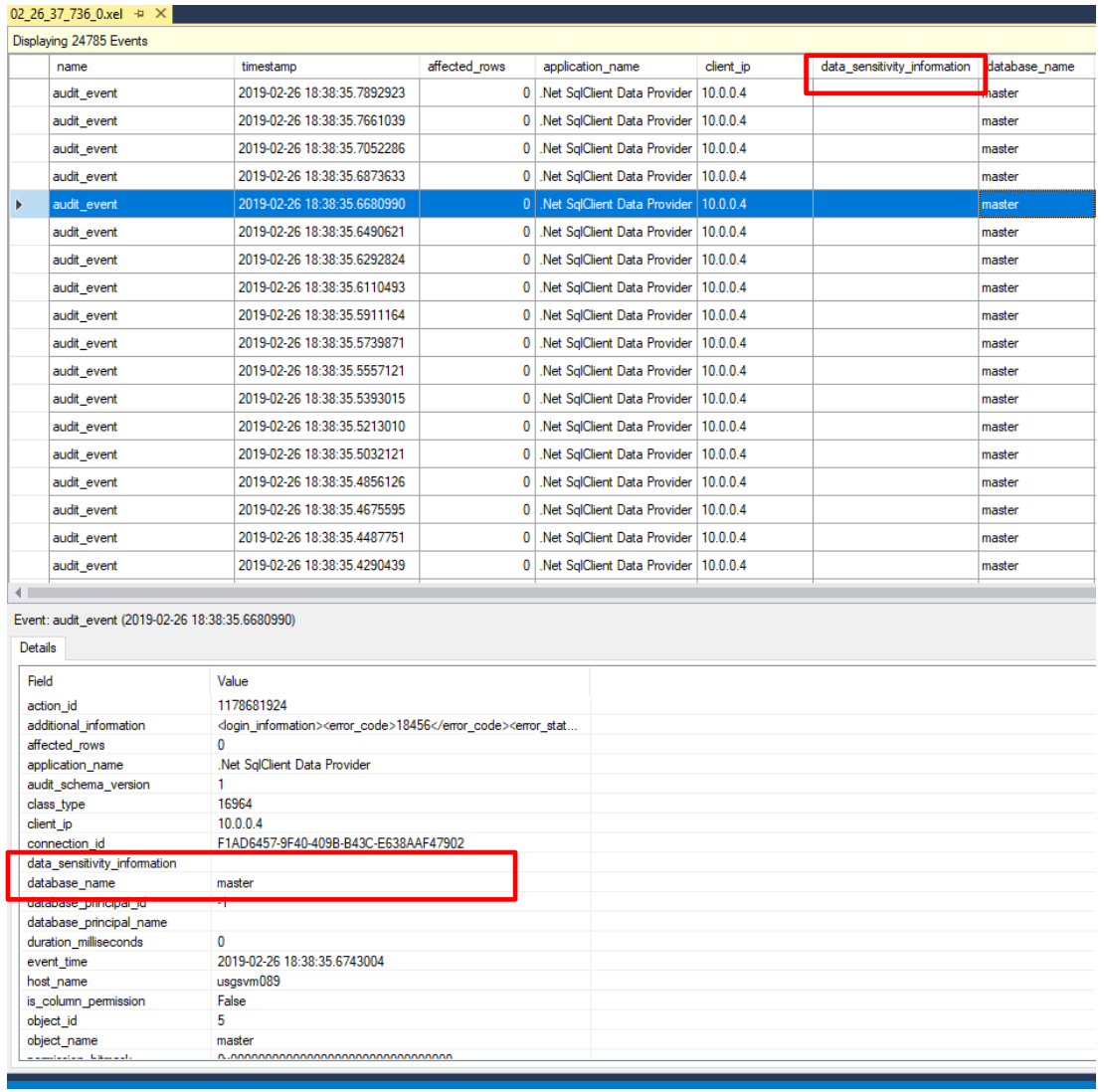
Step 1: Configure auditing for your target Data warehouse. This can be configured for just a single data warehouse or all databases on a server.



Step 2: Navigate to audit logs in storage account and download 'xel' log files to local machine.



Step 3: Open logs using extended events viewer in SSMS. Configure viewer to include 'data_sensitivity_information' column



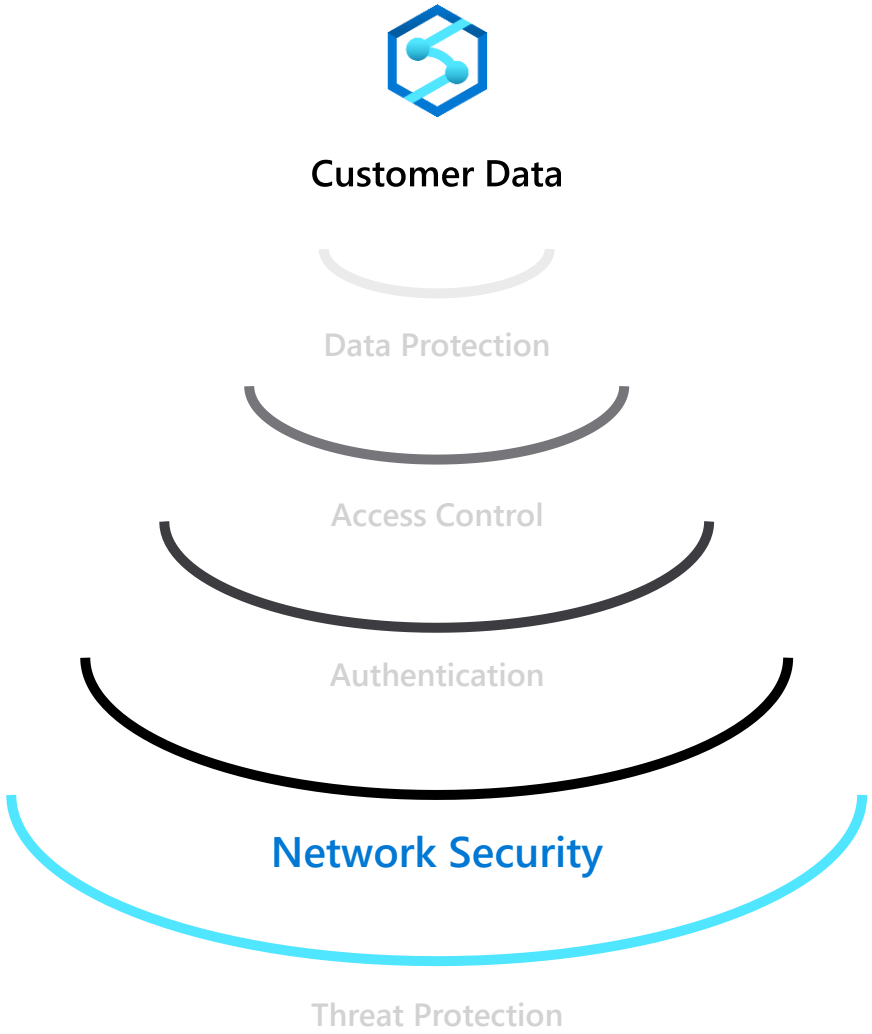
Network Security - Business requirements

How do we implement network isolation?

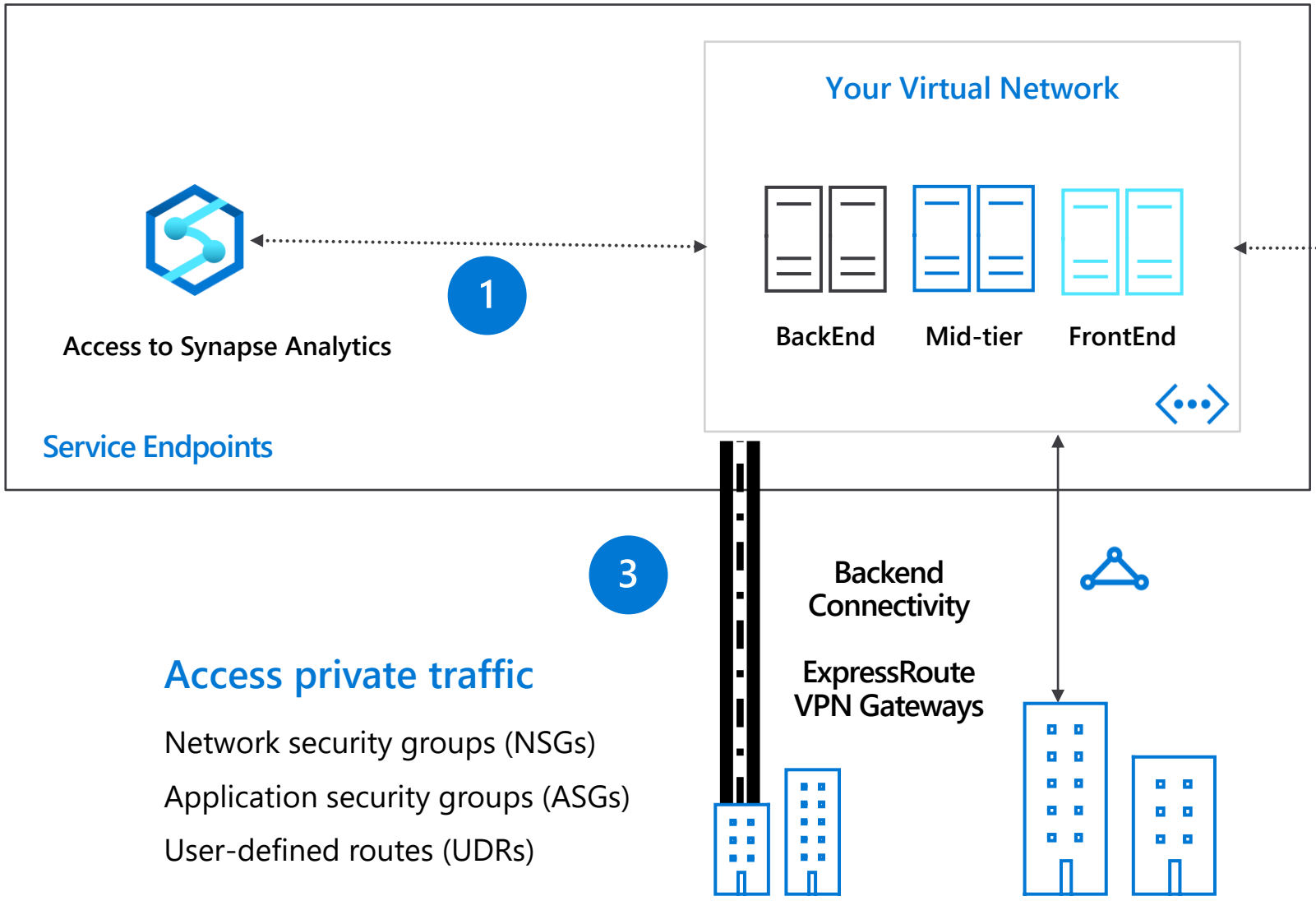
Data at different levels of security needs to be accessed from different locations.

How do we achieve separation?

Disallowing access to entities outside the company's network security boundary.



Azure networking: application-access patterns



Access to/from Internet

DDoS protection

Web application firewall

Azure Firewall

Network virtual appliances

Access private traffic

Network security groups (NSGs)

Application security groups (ASGs)

User-defined routes (UDRs)

Securing with firewalls

Overview

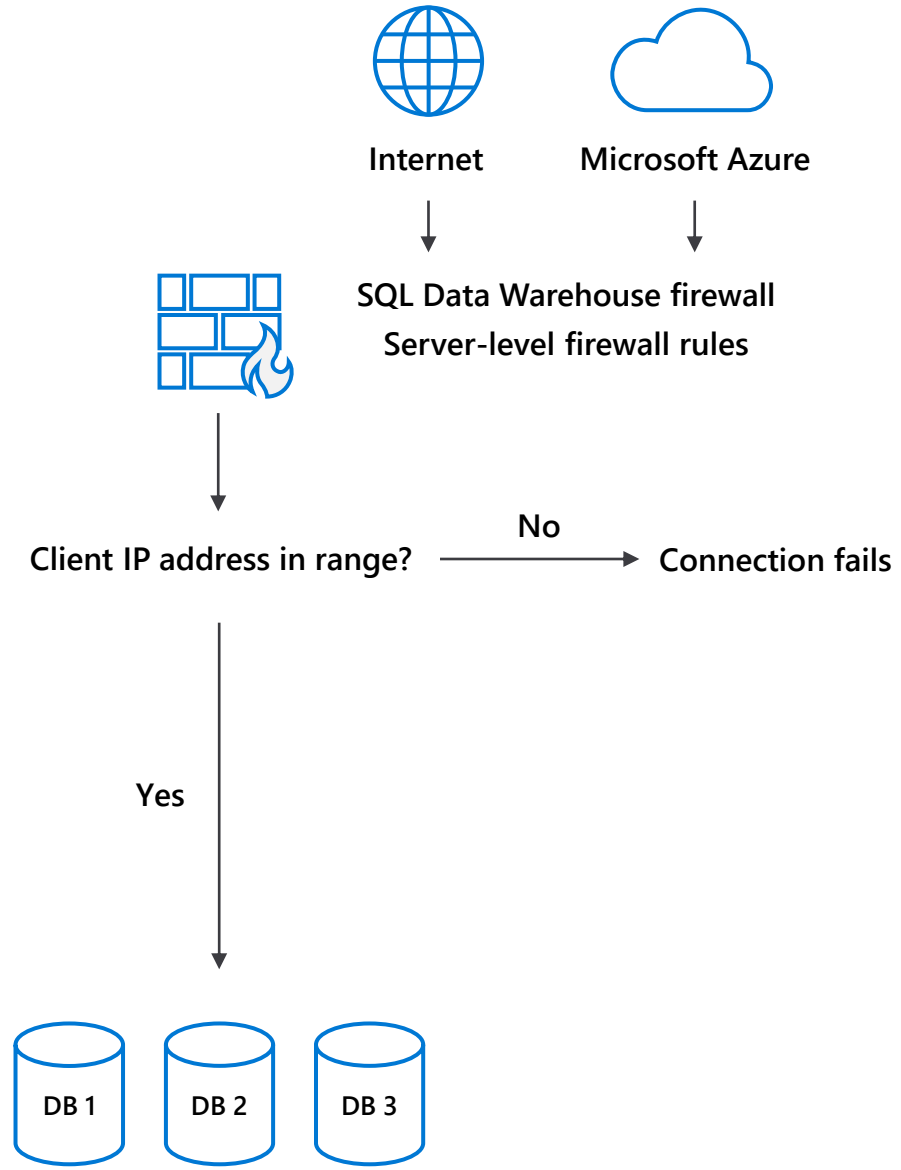
By default, all access to your Azure Synapse Analytics is blocked by the firewall.

Firewall also manages virtual network rules that are based on virtual network service endpoints.

Rules

Allow specific or range of whitelisted IP addresses.

Allow Azure applications to connect.

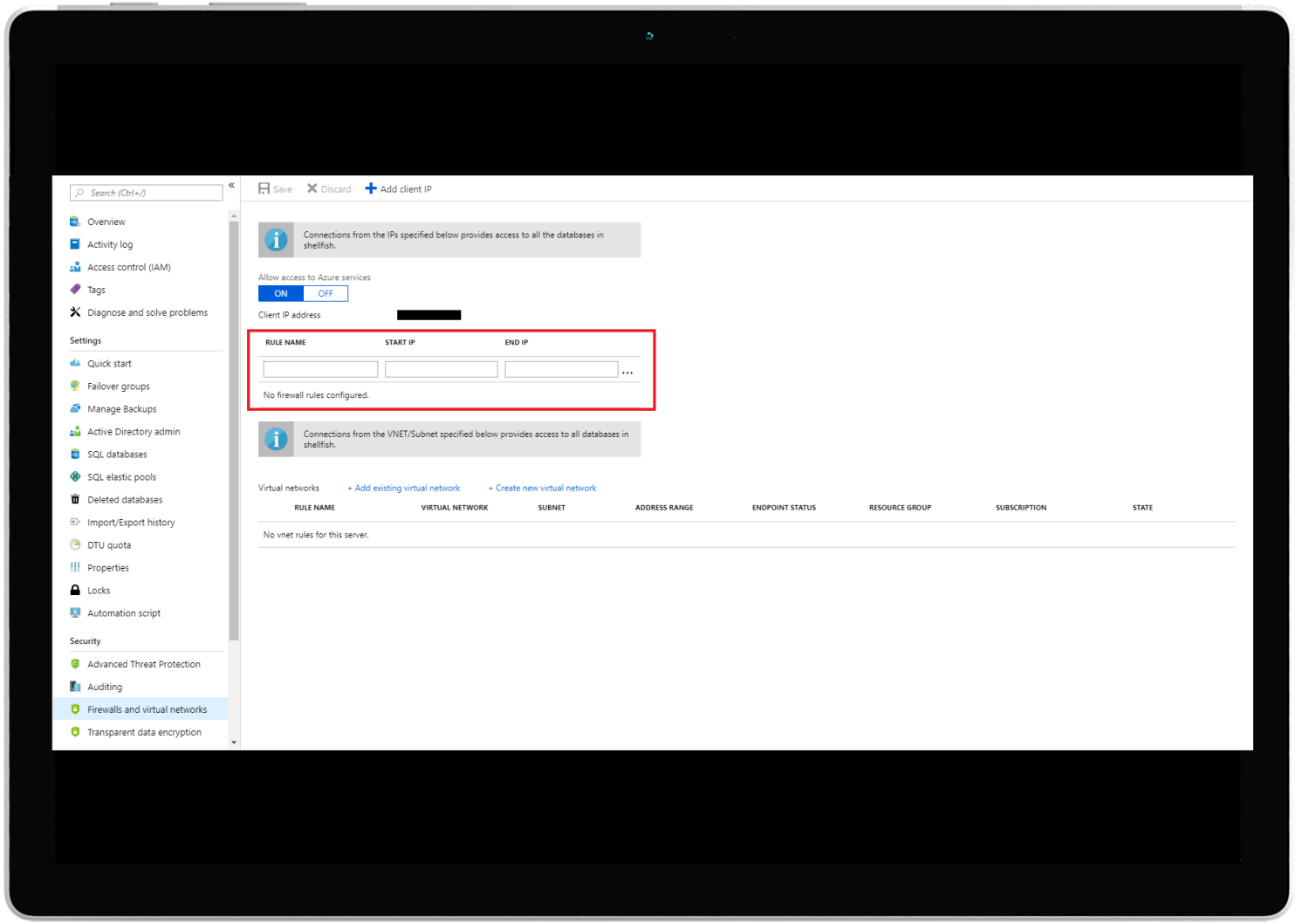


Firewall configuration on the portal

By default, Azure blocks all external connections to port 1433

Configure with the following steps:

Azure Synapse Analytics Resource:
Server name > Firewalls and virtual networks



Firewall configuration using REST API

Managing firewall rules through REST API must be authenticated.

For information, see Authenticating Service Management Requests.

Server-level rules can be created, updated, or deleted using REST API.

To create or update a server-level firewall rule, execute the PUT method.

To remove an existing server-level firewall rule, execute the DELETE method.

To list firewall rules, execute the GET.

```
PUT
https://management.azure.com/subscriptions/{subscriptionId}/resourceGroups/{resourceGroupName}/providers/Microsoft.Sql/servers/{serverName}/firewallRules/{firewallRuleName}?api-version=2014-04-01REQUEST BODY
{
  "properties": {
    "startIpAddress": "0.0.0.3",
    "endIpAddress": "0.0.0.3"
  }
}

DELETE
https://management.azure.com/subscriptions/{subscriptionId}/resourceGroups/{resourceGroupName}/providers/Microsoft.Sql/servers/{serverName}/firewallRules/{firewallRuleName}?api-version=2014-04-01

GET
https://management.azure.com/subscriptions/{subscriptionId}/resourceGroups/{resourceGroupName}/providers/Microsoft.Sql/servers/{serverName}/firewallRules/{firewallRuleName}?api-version=2014-04-01
```

Firewall configuration using PowerShell/T-SQL

Windows PowerShell Azure cmdlets

New-AzureRmSqlServerFirewallRule

Get-AzureRmSqlServerFirewallRule

Set-AzureRmSqlServerFirewallRule

Transact SQL

sp_set_firewall_rule

sp_delete_firewall_rule

```
# PS Allow external IP access to SQL DW
PS C:\> New-AzureRmSqlServerFirewallRule
          -ResourceGroupName "myResourceGroup" `
          -ServerName $servername `
          -FirewallRuleName "AllowSome"
          -StartIpAddress "0.0.0.0"
          -EndIpAddress "0.0.0.0“

-- T-SQL Allow external IP access to SQL DW
EXECUTE sp_set_firewall_rule
          @name = N'ContosoFirewallRule’,
          @start_ip_address = '192.168.1.1’,
          @end_ip_address = '192.168.1.10'
```

VNET configuration on Azure portal

Configure with the following steps:

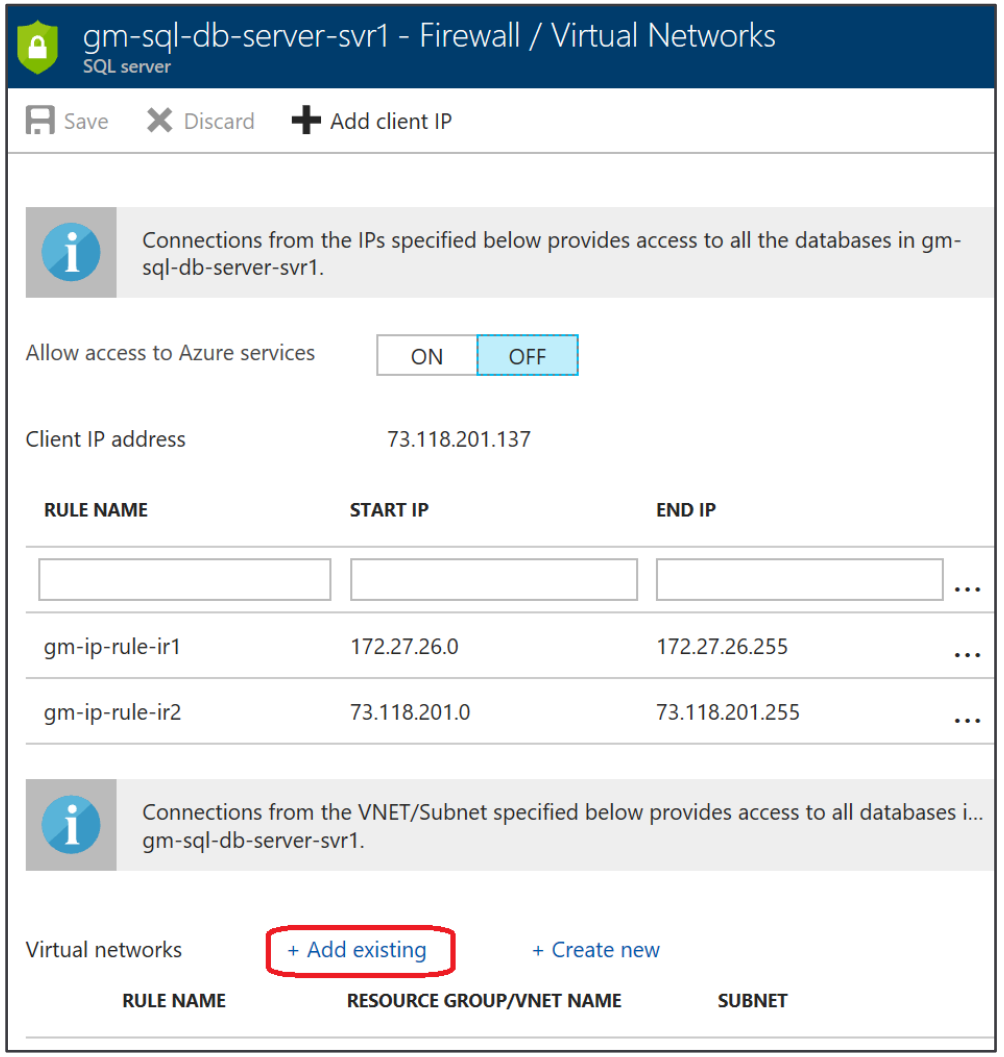
Azure Synapse Analytics Resource:
Server name > Firewalls and virtual networks

REST API and PowerShell alternatives available

Note:

By default, VMs on your subnets cannot communicate with your SQL Data Warehouse.

There must first be a virtual network service endpoint for the rule to reference.

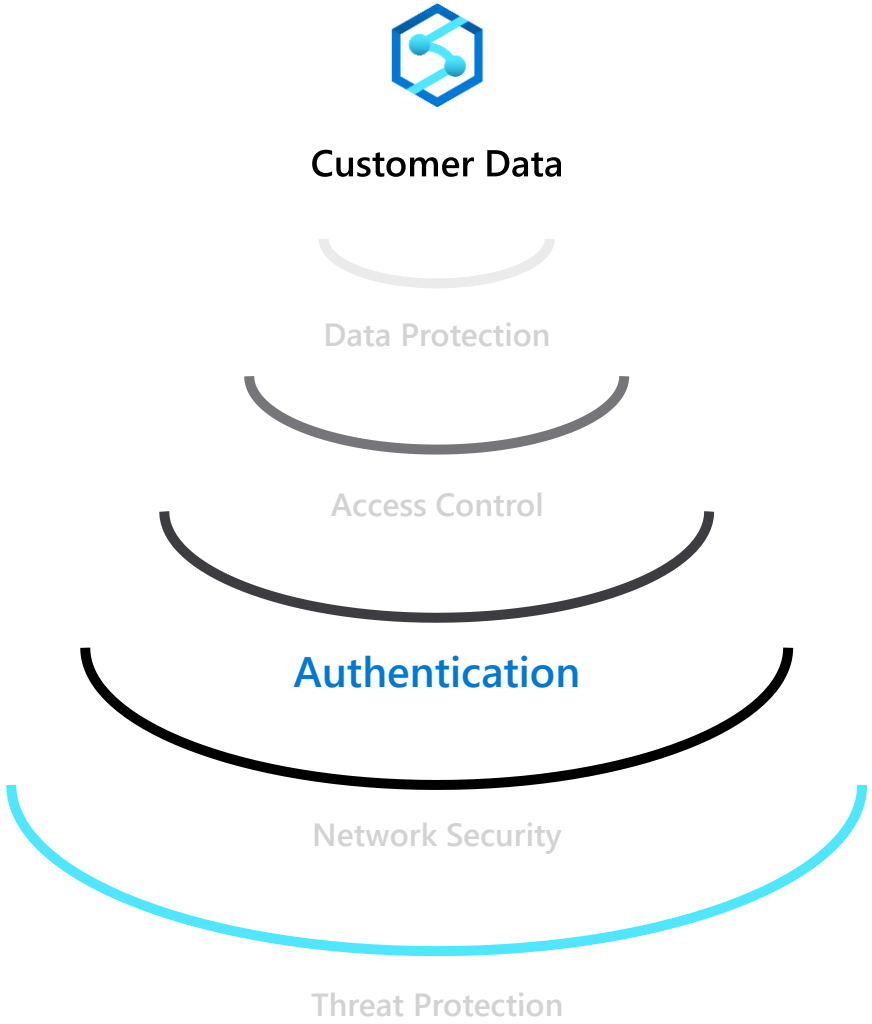


Authentication - Business requirements

How do I configure Azure Active Directory with Azure Synapse Analytics?

I want additional control in the form of multi-factor authentication

How do I allow non-Microsoft accounts to be able to authenticate?



Azure Active Directory authentication

Overview

Manage user identities in one location.

Enable access to Azure Synapse Analytics and other Microsoft services with Azure Active Directory user identities and groups.

Benefits

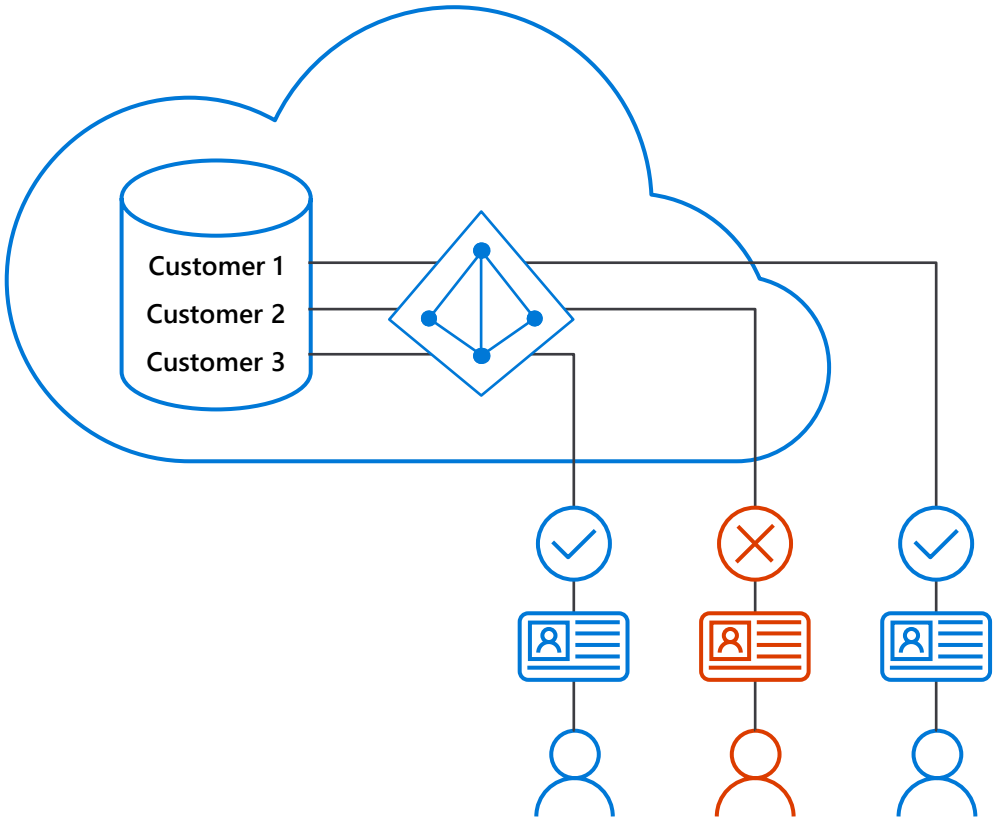
Alternative to SQL Server authentication

Limits proliferation of user identities across databases

Allows password rotation in a single place

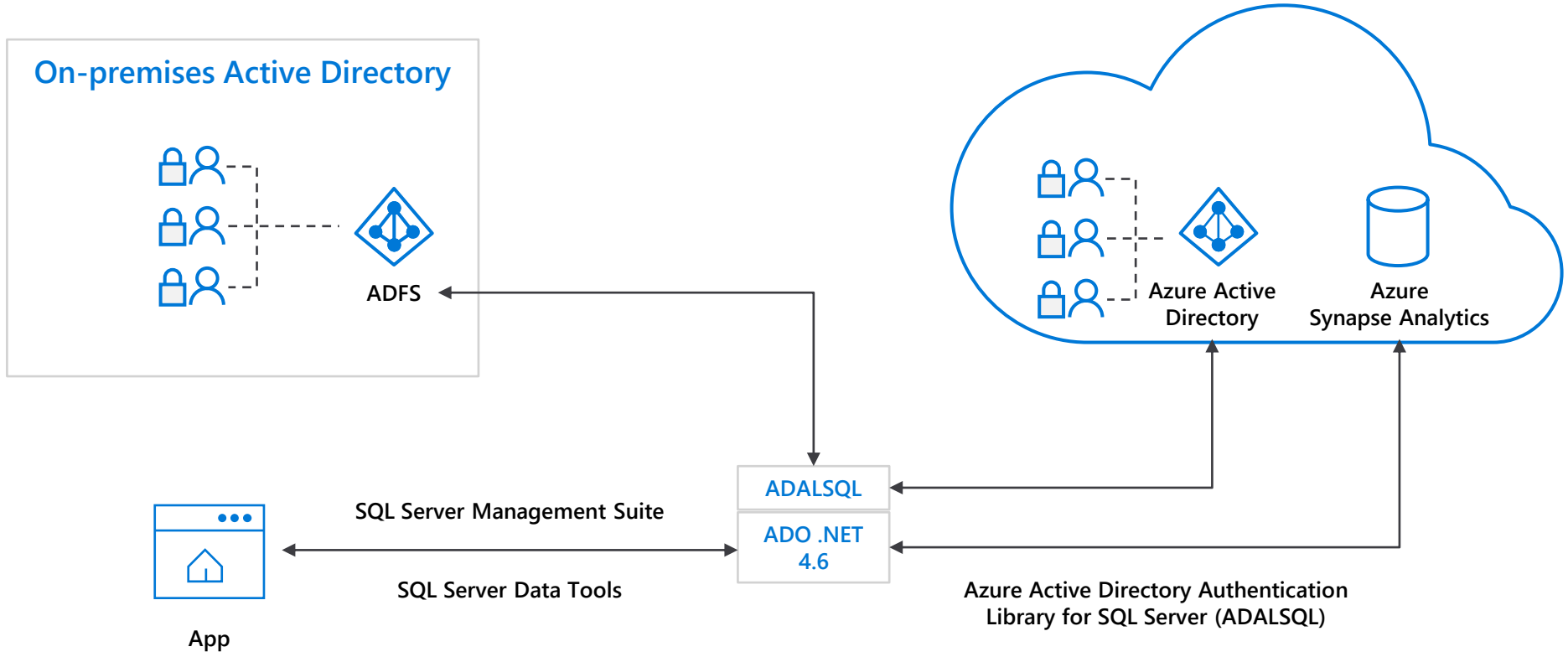
Enables management of database permissions by using external Azure Active Directory groups

Eliminates the need to store passwords



Azure Active Directory trust architecture

Azure Active Directory and Azure Synapse Analytics



SQL authentication

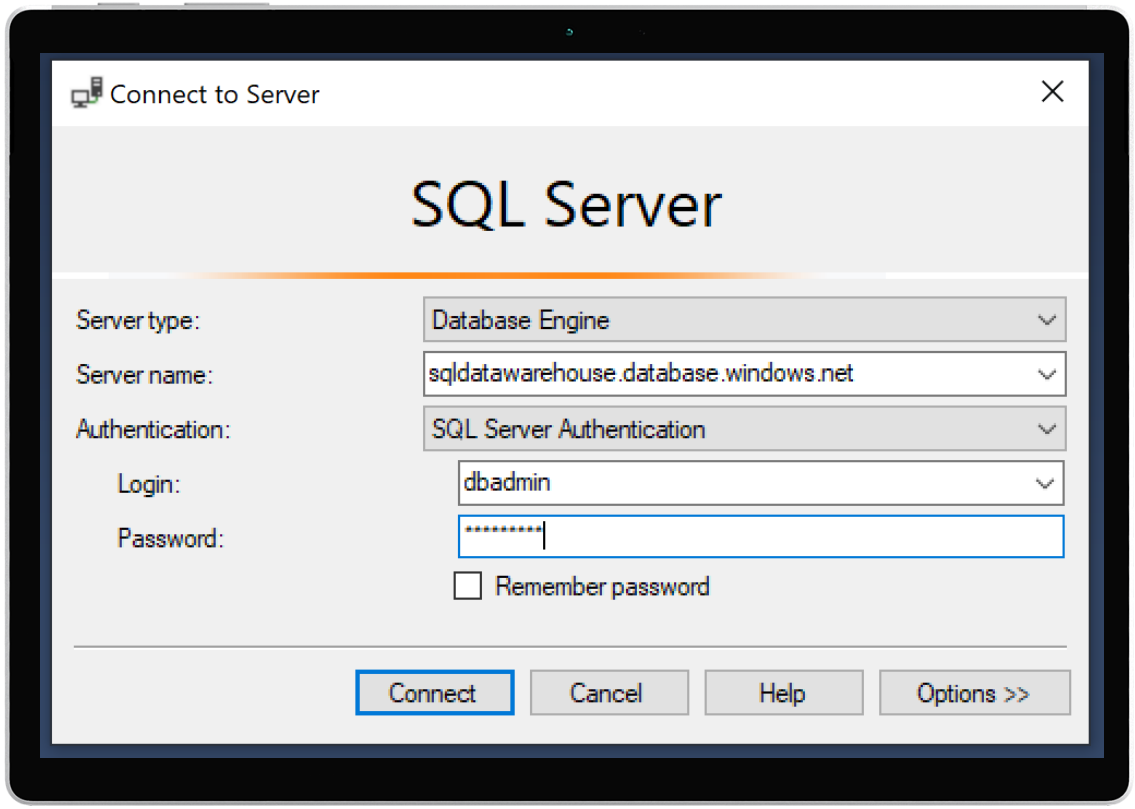
Overview

This authentication method uses a username and password.

When you created the logical server for your data warehouse, you specified a "server admin" login with a username and password.

Using these credentials, you can authenticate to any database on that server as the database owner.

Furthermore, you can create user logins and roles with familiar SQL Syntax.



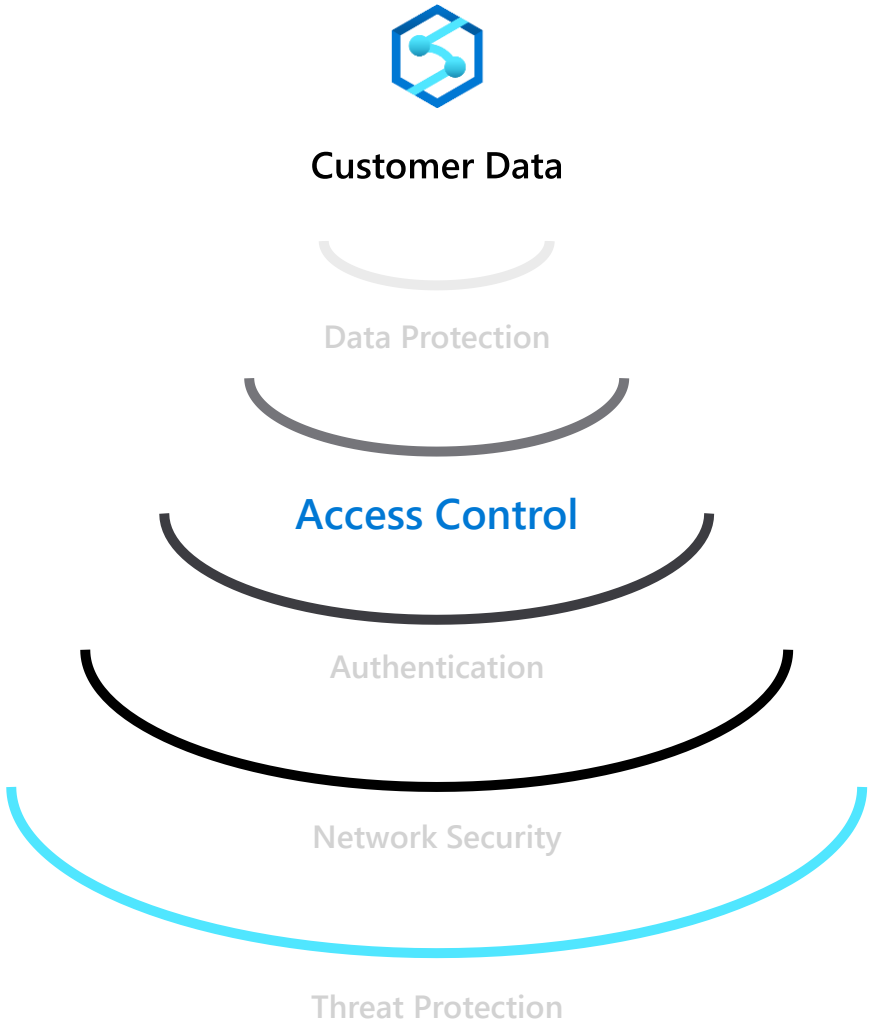

```
-- Connect to master database and create a login
CREATE LOGIN ApplicationLogin WITH PASSWORD = 'Str0ng_password';
CREATE USER ApplicationUser FOR LOGIN ApplicationLogin;

-- Connect to SQL DW database and create a database user
CREATE USER DatabaseUser FOR LOGIN ApplicationLogin;
```

Access Control - Business requirements

How do I restrict access to sensitive data to specific database users?

How do I ensure users only have access to relevant data?

For example, in a hospital only medical staff should be allowed to see patient data that is relevant to them—and not every patient's data.



Object-level security (tables, views, and more)

Overview

GRANT controls permissions on designated tables, views, stored procedures, and functions.

Prevent unauthorized queries against certain tables.

Simplifies design and implementation of security at the database level as opposed to application level.

```
-- Grant SELECT permission to user RosaQdM on table Person.Address in the AdventureWorks2012 database
GRANT SELECT ON OBJECT::Person.Address TO RosaQdM;
GO
-- Grant REFERENCES permission on column BusinessEntityID in view HumanResources.vEmployee to user Wanida
GRANT REFERENCES(BusinessEntityID) ON OBJECT::HumanResources.vEmployee to Wanida with GRANT OPTION;
GO
-- Grant EXECUTE permission on stored procedure HumanResources.uspUpdateEmployeeHireInfo to an application role called Recruiting11
USE AdventureWorks2012;
GRANT EXECUTE ON OBJECT::HumanResources.uspUpdateEmployeeHireInfo TO RECRUITING 11;
GO
```

Row-level security (RLS)

Overview

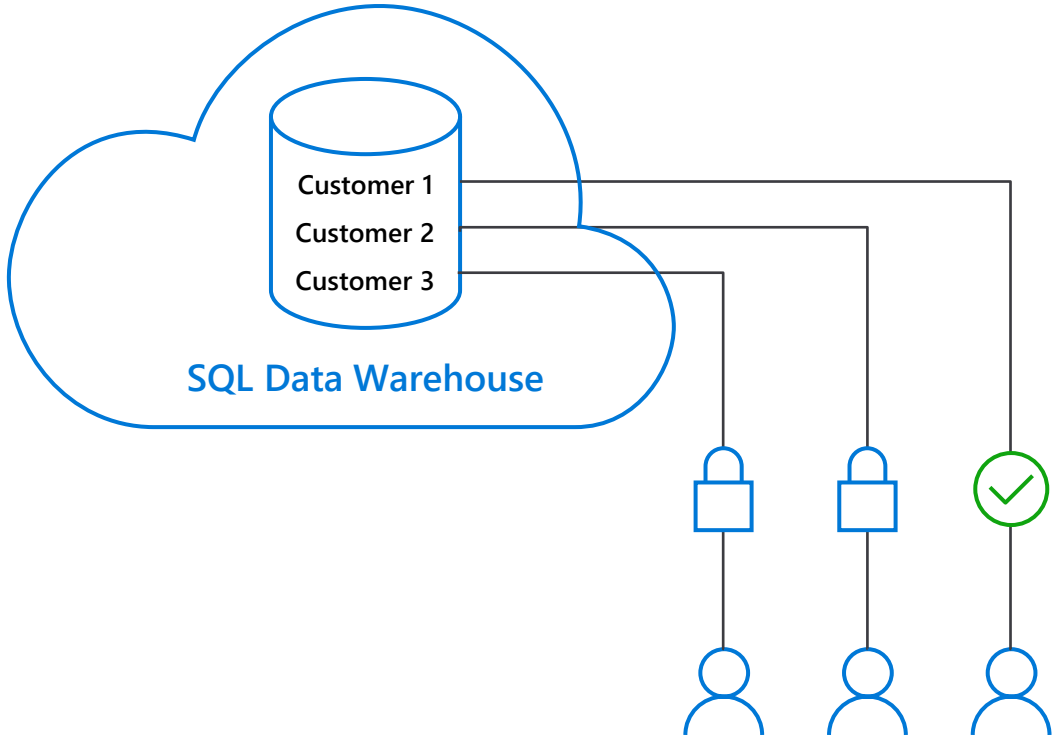
Fine grained access control of specific rows in a database table.

Help prevent unauthorized access when multiple users share the same tables.

Eliminates need to implement connection filtering in multi-tenant applications.

Administer via SQL Server Management Studio or SQL Server Data Tools.

Easily locate enforcement logic inside the database and schema bound to the table.



Row-level security

Creating policies

Filter predicates silently filter the rows available to read operations (SELECT, UPDATE, and DELETE).

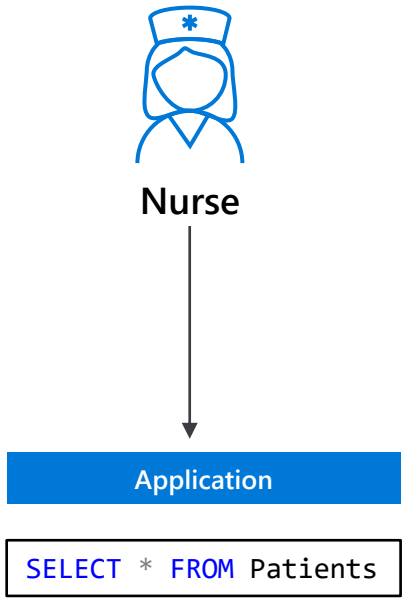
The following examples demonstrate the use of the CREATE SECURITY POLICY syntax

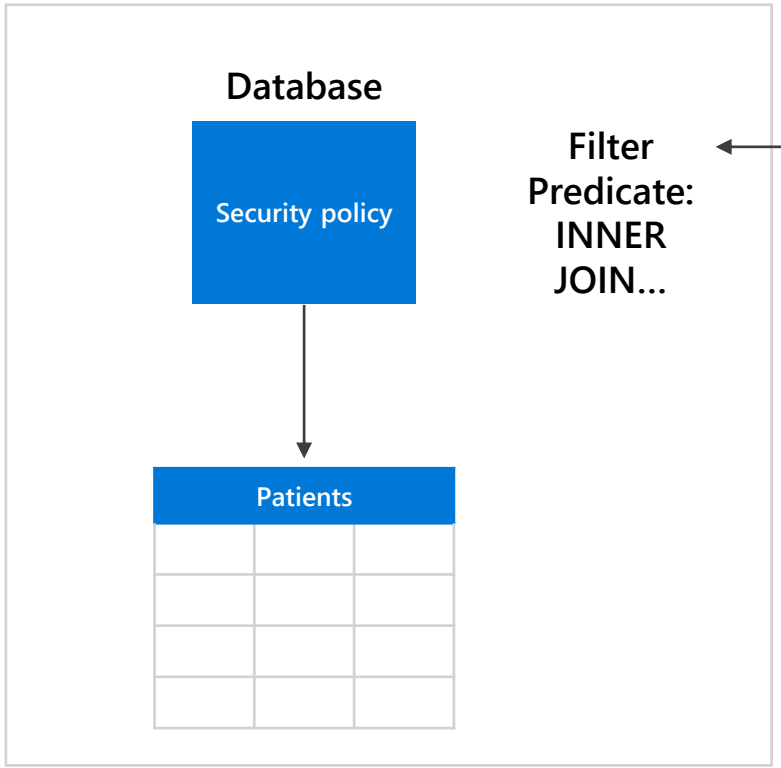
```
-- The following syntax creates a security policy with a filter predicate for the Customer table
CREATE SECURITY POLICY [FederatedSecurityPolicy]
ADD FILTER PREDICATE [rls].[fn_securitypredicate]([CustomerId])
ON [dbo].[Customer];


-- Create a new schema and predicate function, which will use the application user ID stored in CONTEXT_INFO to filter rows.
CREATE FUNCTION rls.fn_securitypredicate (@AppUserId int)
RETURNS TABLE
WITH SCHEMABINDING
AS
RETURN (
SELECT 1 AS fn_securitypredicate_result
WHERE
DATABASE_PRINCIPAL_ID() = DATABASE_PRINCIPAL_ID('dbo') -- application context
AND CONTEXT_INFO() = CONVERT(VARBINARY(128), @AppUserId));
GO
```

Row-level security

Three steps:

1. Policy manager creates filter predicate and security policy in T-SQL, binding the predicate to the patients table.
2. App user (e.g., nurse) selects from Patients table.
3. Security policy transparently rewrites query to apply filter predicate.





Filter Predicate: INNER JOIN...

Policy manager

```
CREATE FUNCTION dbo.fn_securitypredicate(@wing int)
    RETURNS TABLE WITH SCHEMABINDING AS
    return SELECT 1 as [fn_securitypredicate_result] FROM
        StaffDuties d INNER JOIN Employees e
        ON (d.EmpId = e.EmpId)
        WHERE e.UserSID = SUSER_SID() AND @wing = d.Wing;

CREATE SECURITY POLICY dbo.SecPol
    ADD FILTER PREDICATE dbo.fn_securitypredicate(Wing) ON Patients
    WITH (STATE = ON)
```

```
SELECT * FROM Patients
   SEMIJOIN APPLY dbo.fn_securitypredicate(patients.Wing);
```

```
SELECT Patients.* FROM Patients,
   StaffDuties d INNER JOIN Employees e ON (d.EmpId = e.EmpId)
   WHERE e.UserSID = SUSER_SID() AND Patients.wing = d.Wing;
```

Column-level security

Overview

Control access of specific columns in a database table based on customer's group membership or execution context.

Simplifies the design and implementation of security by putting restriction logic in database tier as opposed to application tier.

Administer via GRANT T-SQL statement.

Both Azure Active Directory (AAD) and SQL authentication are supported.

Column-level security

Three steps:

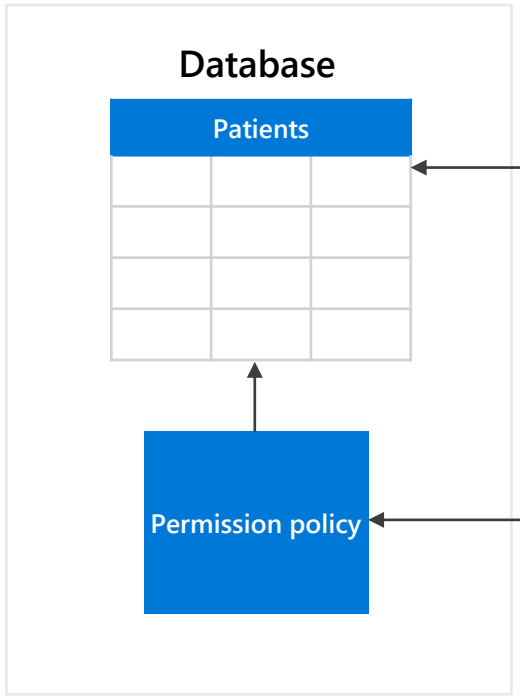
1. Policy manager creates permission policy in T-SQL, binding the policy to the Patients table on a specific group.
2. App user (for example, a nurse) selects from Patients table.
3. Permission policy prevents access on sensitive data.

Nurse

Application

```
SELECT * FROM Membership;

Msg 230, Level 14, State 1, Line 12
The SELECT permission was denied on the column
'SSN' of the object 'Membership', database
'CLS_TestDW', schema 'dbo'.
```

Queries executed as 'Nurse' will fail if they include the SSN column



Policy manager

```
CREATE TABLE Patients (
  PatientID int IDENTITY,
  FirstName varchar(100) NULL,
  SSN char(9) NOT NULL,
  LastName varchar(100) NOT NULL,
  Phone varchar(12) NULL,
  Email varchar(100) NULL
);
```

```
GRANT SELECT ON Patients (
  PatientID, FirstName, LastName, Phone, Email
) TO Nurse;
```

Allow 'Nurse' to access all columns except for sensitive SSN column

Data Protection - Business requirements

How do I protect sensitive data against unauthorized (high-privileged) users?

What key management options do I have?

Dynamic Data Masking

Overview

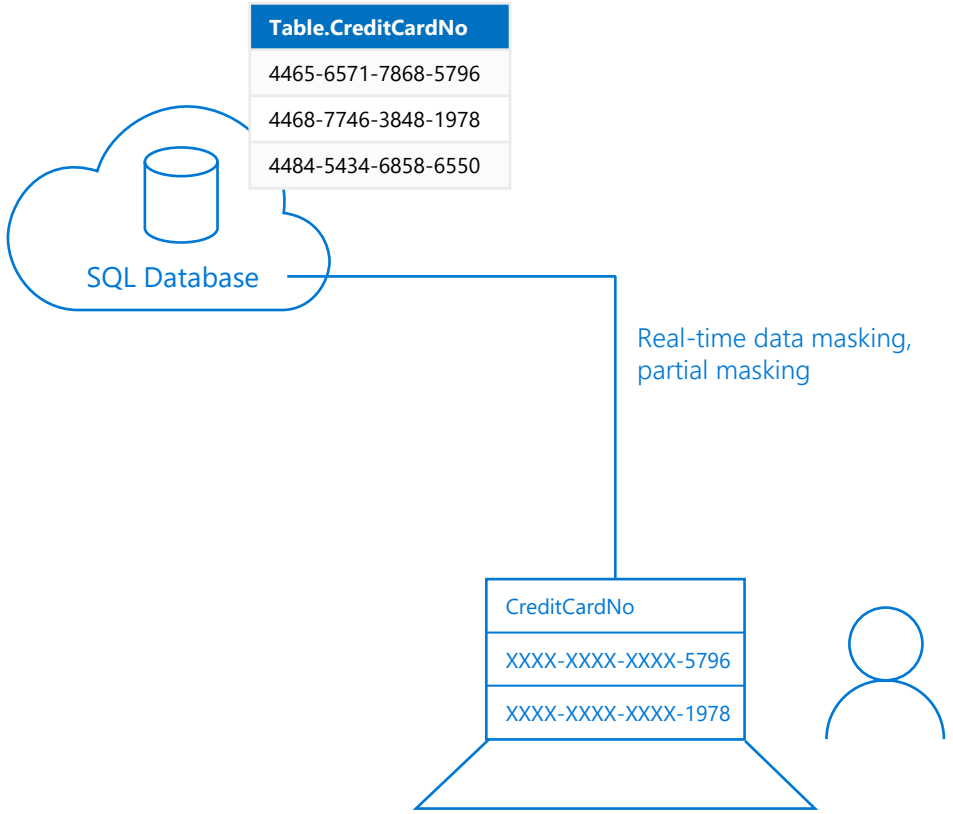
Prevent abuse of sensitive data by hiding it from users

Easy configuration in new Azure Portal

Policy-driven at table and column level, for a defined set of users

Data masking applied in real-time to query results based on policy

Multiple masking functions available, such as full or partial, for various sensitive data categories (credit card numbers, SSN, etc.)



Dynamic Data Masking

Three steps

1. Security officer defines dynamic data masking policy in T-SQL over sensitive data in the Employee table. The security officer uses the built-in masking functions (default, email, random)

2. The app-user selects from the Employee table

3. The dynamic data masking policy obfuscates the sensitive data in the query results for non-privileged users

Security officer

1

```
ALTER TABLE [Employee]
ALTER COLUMN [SocialSecurityNumber]
ADD MASKED WITH (FUNCTION = 'DEFAULT()')

ALTER TABLE [Employee]
ALTER COLUMN [Email]
ADD MASKED WITH (FUNCTION = 'EMAIL()')

ALTER TABLE [Employee]
ALTER COLUMN [Salary]
ADD MASKED WITH (FUNCTION = 'RANDOM(1,20000)')

GRANT UNMASK to admin1
```

2

Business app

```
SELECT [First Name],
       [Social Security Number],
       [Email],
       [Salary]
FROM   [Employee]
```

3

Non-masked data (admin login)

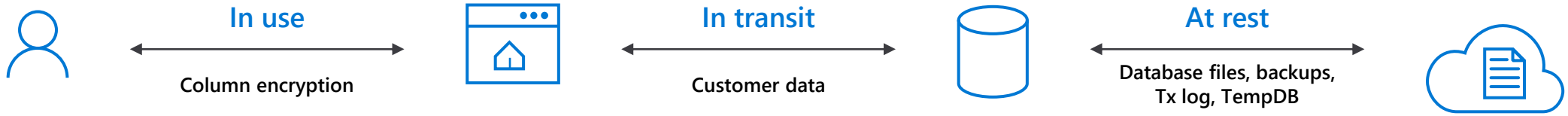
	First Name	Social Security Num...	Email	Salary
1	LILA	758-10-9637	lila.barnett@comcast.net	1012794
2	JAMIE	113-29-4314	jamie.brown@ntlworld.com	1025713
3	SHELLEY	550-72-2028	shelley.lynn@charter.net	1040131
4	MARCELLA	903-94-5665	marcella.estrada@comcast.net	1040753
5	GILBERT	376-79-4787	gilbert.juarez@verizon.net	1041308

Masked data (admin1 login)

	First Name	Social Security Number	Email	Salary
1	LILA	XXX-XX-XX37	lXX@XXXX.net	8940
2	JAMIE	XXX-XX-XX14	jXX@XXXX.com	19582
3	SHELLEY	XXX-XX-XX28	sXX@XXXX.net	3713
4	MARCELLA	XXX-XX-XX65	mXX@XXXX.net	11572
5	GILBERT	XXX-XX-XX87	gXX@XXXX.net	4487

Types of data encryption

Data Encryption	Encryption Technology	Customer Value
In transit	Transport Layer Security (TLS) from the client to the server TLS 1.2	Protects data between client and server against snooping and man-in-the-middle attacks
At rest	Transparent Data Encryption (TDE) for Azure Synapse Analytics	Protects data on the disk User or Service Managed key management is handled by Azure, which makes it easier to obtain compliance



Transparent data encryption (TDE)

Overview

All customer data encrypted at rest

TDE performs real-time I/O encryption and decryption of the data and log files.

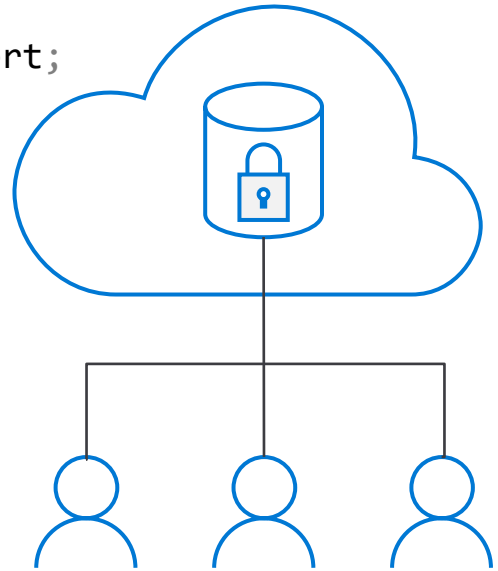
Service OR User managed keys.

Application changes kept to a minimum.

Transparent encryption/decryption of data in a TDE-enabled client driver.

Compliant with many laws, regulations, and guidelines established across various industries.

```
USE master;
GO
CREATE MASTER KEY ENCRYPTION BY PASSWORD = '<UseStrongPasswordHere>';
go
CREATE CERTIFICATE MyServerCert WITH SUBJECT = 'My DEK Certificate';
go
USE MyDatabase;
GO
CREATE DATABASE ENCRYPTION KEY
WITH ALGORITHM = AES_128
ENCRYPTION BY SERVER CERTIFICATE MyServerCert;
GO
ALTER DATABASE MyDatabase
SET ENCRYPTION ON;
GO
```



Transparent data encryption (TDE)

Key Vault

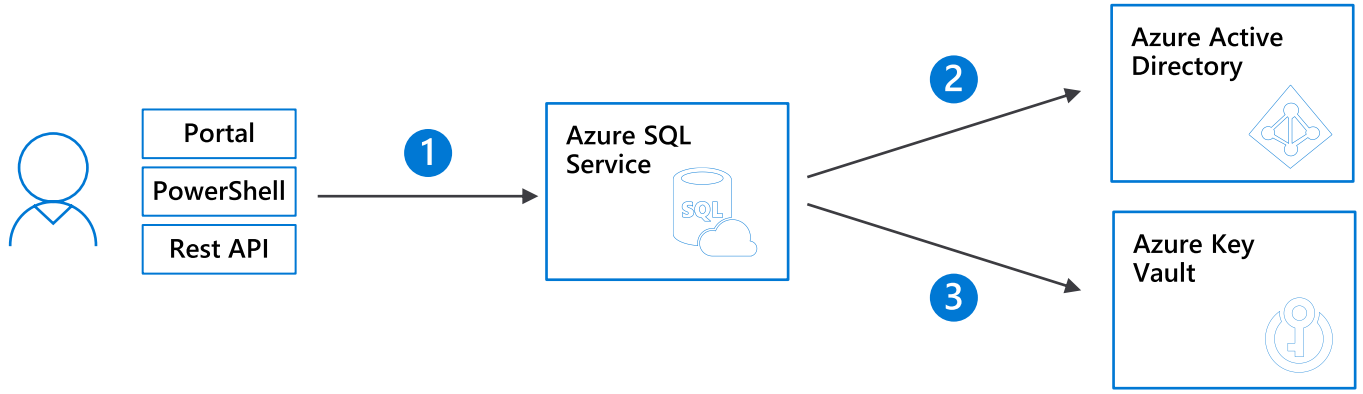
Benefits with User Managed Keys

Assume more control over who has access to your data and when.

Highly available and scalable cloud-based key store.

Central key management that allows separation of key management and data.

Configurable via Azure Portal, PowerShell, and REST API.



1. The Key Vault admin grants vault access to the SQL Database server using its unique Azure Active Directory (AD) identity
2. The server uses its Azure AD identity to authenticate with Azure AD for access to your Key Vault
3. The server sends get, wrap key, and unwrap key request to the asymmetric key in key Vault for database encryption key protection.


Thank You!
дякую
ขอบคุณครับ
Tak
감사합니다
متشكرم
ευχαριστώ
Teşekkürler
Grazie
Dank u Wel
Děkuji
благодаря
Ďakujem
多謝晒
Dziękuję
شكراً
Salamat Po
Danke
நன்றி
谢谢
Hvala
Kiitos
Obrigado
Mulţumesc
شكريه
спасибо
Köszönöm
ありがとうございます
Cám ơn
Tack
Gracias
Terima Kasih

Microsoft

https://twitter.com/anBenedetti

https://github.com/anbened

https://www.linkedin.com/in/abenedetti/