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Application Security in Azure

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@zaalion

Overview

What Applications are We Aiming to Protect?

- Hosted in Microsoft Azure
  - PaaS (Hosted in Azure App Services)
    - Web applications
    - Serverless (e.g. Functions Apps)
  - IaaS (Hosted in virtual machines)
    - Any applications

Topics to Cover in This Course

- Protecting applications hosted in the Microsoft Azure cloud
  - Protecting secrets in the application code (Azure KV, MSI)
  - Protecting virtual machines (NSGs)
  - Protecting web applications against common attacks (WAF)

Protecting Secrets in the Application Code

Protecting Secrets in the Application Code

```
public class ValuesController : ApiController
{
    // GET api/values
    public Dictionary<string, string> Get()
    {
        var connectingString = "Server=tcp:azuresqlmsidemosrv.database.windows.net,1433;" +
            "Initial Catalog=MSIDEMO;Persist Security Info=False" +
            ";MultipleActiveResultSets=False;" +
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        var capitals = new Dictionary<string, string>();

        using (var sqlConnection = new SqlConnection(connectingString))
        {
            var sqlCommand = new SqlCommand("SELECT Country, Capital FROM CountryInfo", sqlConnection);

            var accessToken = (new AzureServiceTokenProvider()).GetAccessTokenAsync("https://database.windows.net/").Result;
            sqlConnection.AccessToken = accessToken;

            sqlConnection.Open();

            var reader = sqlCommand.ExecuteReader();
```
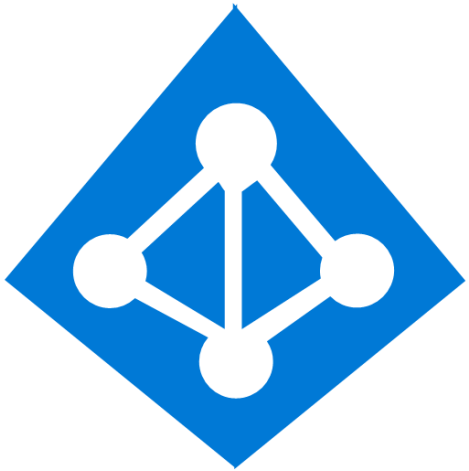

Protecting Secrets in the Application Code

Protecting Secrets in the Application Code

Azure Key Vault



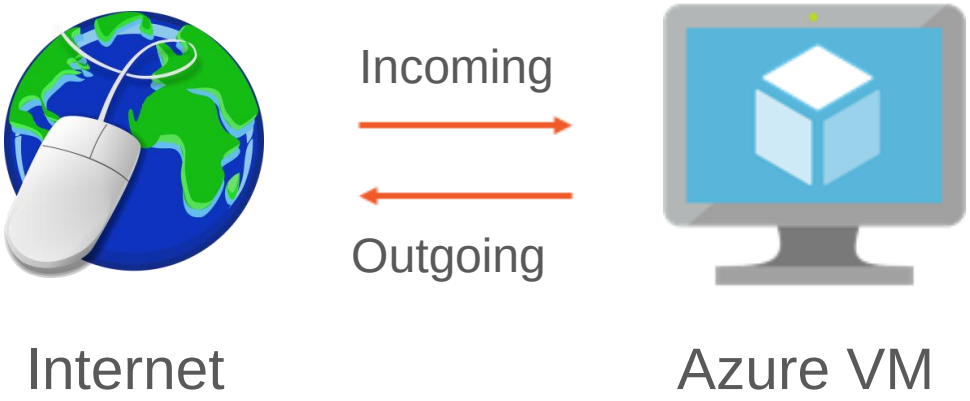
Managed Identity (MSI)

Protecting virtual machines (NSGs)

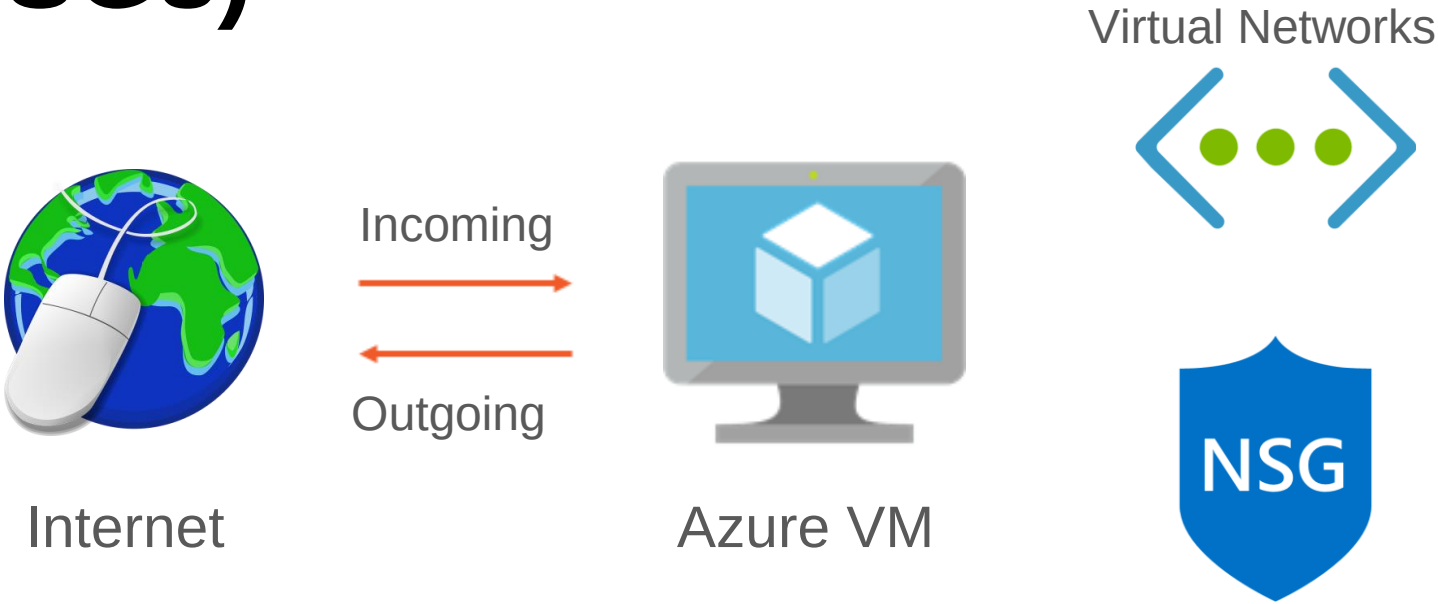
Protecting virtual machines (NSGs)

Azure VM

Protecting virtual machines (NSGs)



Protecting virtual machines (NSGs)



Protecting web applications against common attacks (WAF)

Protecting web applications against common attacks (WAF)

App Services

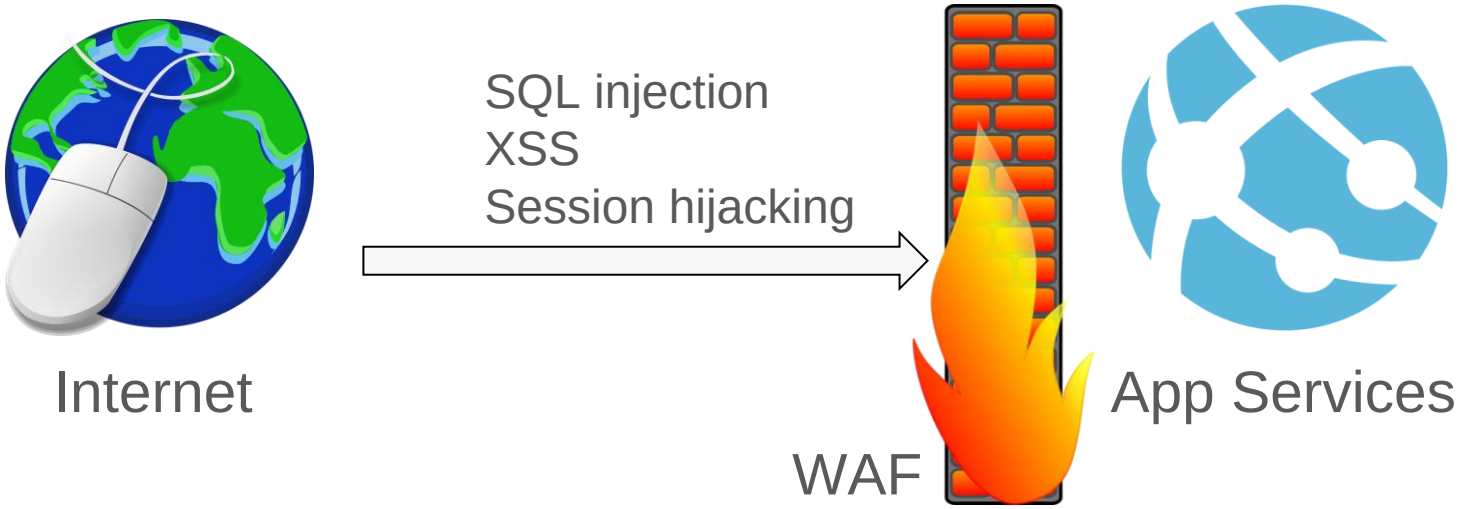
Protecting web applications against common attacks (WAF)

Internet

SQL injection
XSS
Session hijacking

App Services

Protecting web applications against common attacks (WAF)

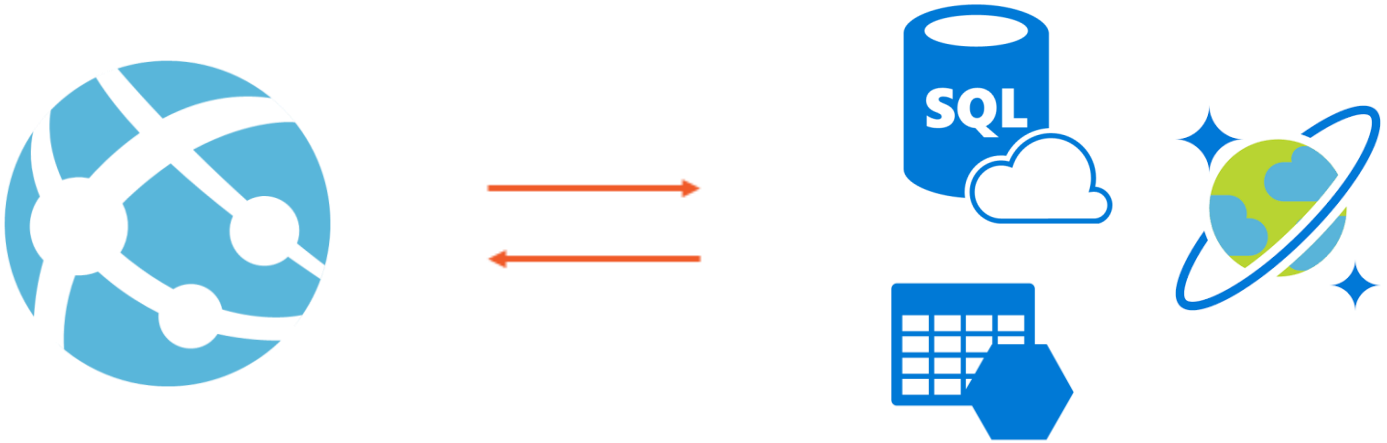


Application Security Comes Hand in Hand with Data Security

Application Security Comes Hand in Hand with Data Security

Application

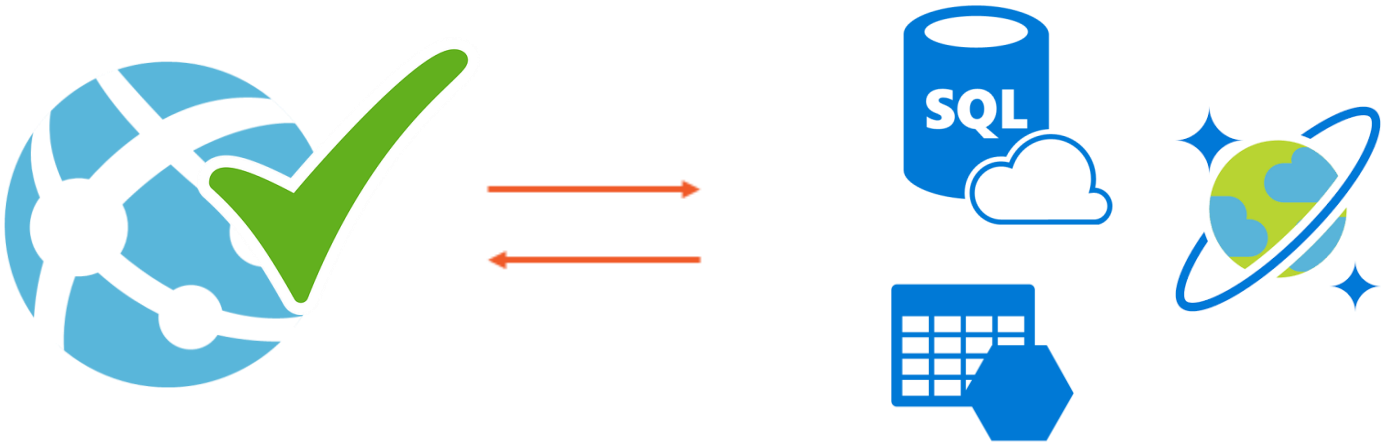
Application Security Comes Hand in Hand with Data Security



Application

Data

Application Security Comes Hand in Hand with Data Security



Application

Data

Application Security Comes Hand in Hand with Data Security

- Securing Data in Microsoft Azure
  - Securing data in transit
    - SSL/TLS
  - Securing data at rest
    - Azure SQL Database
    - Azure Cosmos DB
    - Azure Storage Account
  - Securing data in use
    - Azure Confidential Compute

Protecting Secrets in the Code

Azure Key Vault and Managed Identities

Protecting Secrets in the Application Code

Protecting Secrets in the Application Code

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            sqlConnection.AccessToken = accessToken;

            sqlConnection.Open();

            var reader = sqlCommand.ExecuteReader();
```

Protecting Secrets in the Application Code

Protecting Secrets in the Application Code

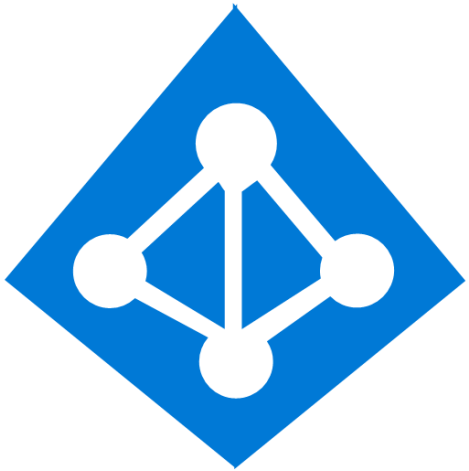
- Secrets:
  - Database connection strings
  - Passwords
  - Encryption keys
  - Cache connection strings
  - Any sensitive data
- These secrets should NOT live in the application source code

Protecting Secrets in the Application Code

- Why?
  - Code will be checked into the source control.
  - No easy way to rotate or expire these secrets.
  - No easy way to control access to the secrets.
  - Maintenance nightmare

Protecting Secrets in the Application Code

Azure Key Vault



Managed Identity (MSI)

Azure Key Vault

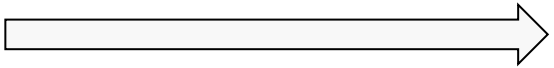
- Can be used to Securely store and tightly control access to:
  - Tokens
  - Passwords
  - Certificates
  - API keys, and other secrets

Azure Key Vault

Stores the connection string
in the code

Azure Key Vault

Use the connection string



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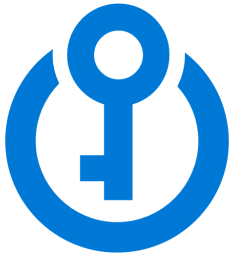
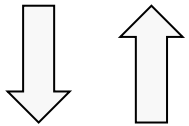
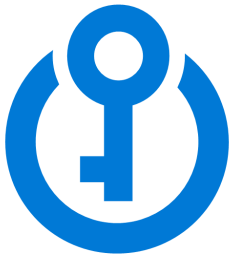
Azure Key Vault



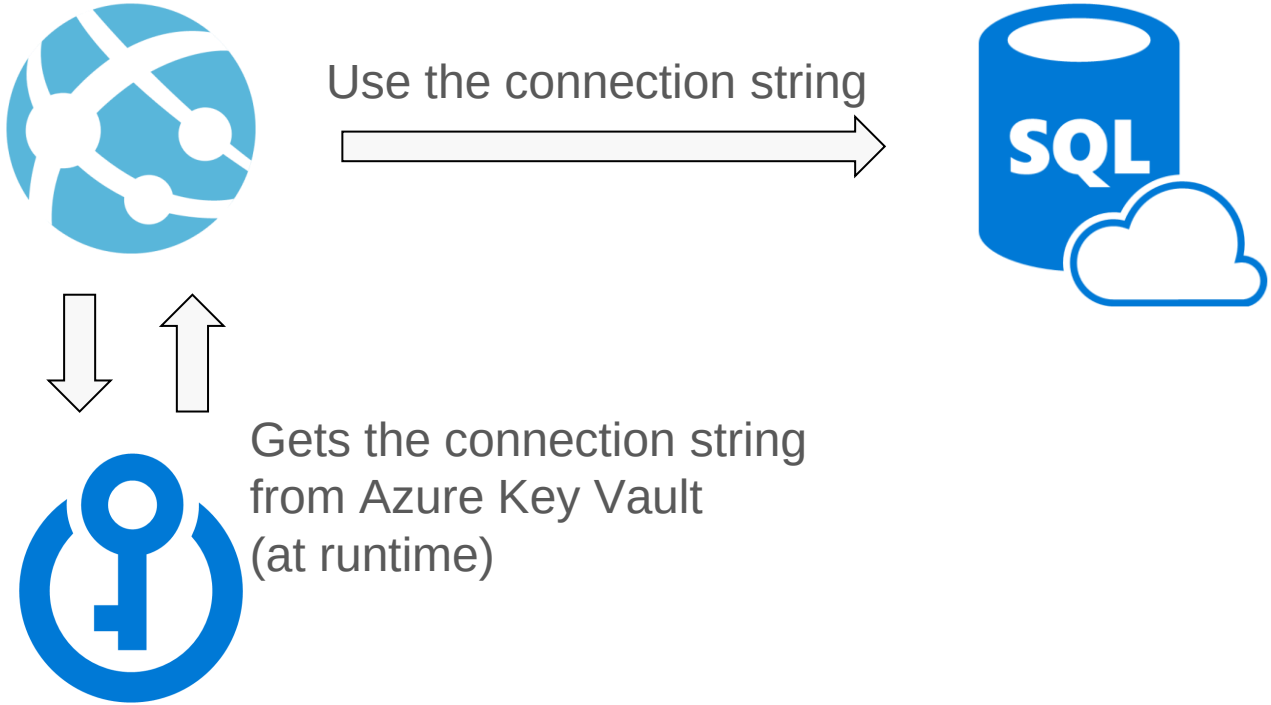
Azure Key Vault





Gets the connection string
from Azure Key Vault
(at runtime)

Azure Key Vault



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            var accessToken = (new AzureServiceTokenProvider()).GetAccessTokenAsync("https://database.windows.net/").Result;
            sqlConnection.AccessToken = accessToken;

            sqlConnection.Open();

            var reader = sqlCommand.ExecuteReader();
```
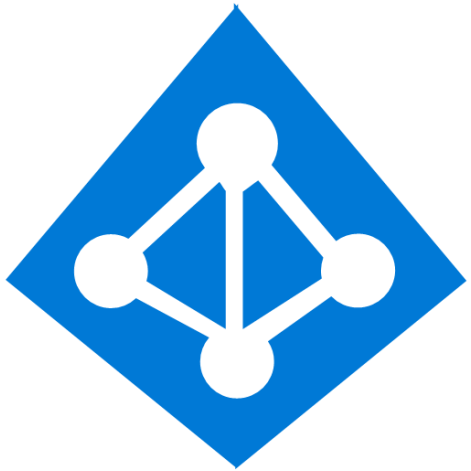

Protecting Secrets in the Application Code

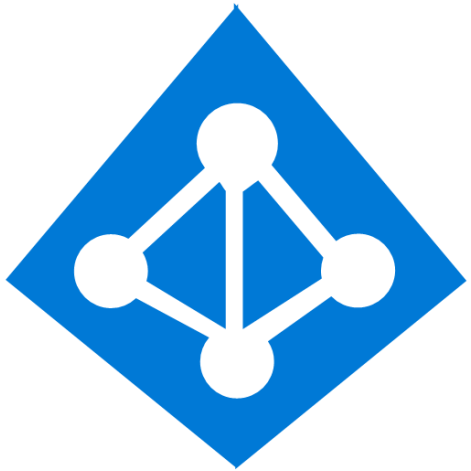
```
[FunctionName("GetSecretFromKV")]
public static  IActionResult Run(
    [HttpTrigger(AuthorizationLevel.Function, "get", "post", Route = null)] HttpRequest req,
    ILogger log)
{
    var kv = new KeyVaultClient(new KeyVaultClient.AuthenticationCallback(GetAccessToken));

    var secretUrl = "https://kv-msi-01.vault.azure.net/secrets/myname/56c2905096f14c689d928da072139c72";
    var secret = kv.GetSecretAsync(secretUrl).Result;
    var myName = secret.Value;

    return myName != null
        ? (ActionResult)new OkObjectResult($"Hello, {myName}")
        : new BadRequestObjectResult("Please pass a name on the query string or in the request body");
}

private static async Task<string> GetAccessToken(string authority, string resource, string scope)
{
```

Managed Identity (MSI)



Managed Identity (MSI)

- Provides Azure services with an automatically managed identity.
- Authenticate to any supporting service without any credentials in your code.
- You can achieve **credential-free code**.



Credential-free Code

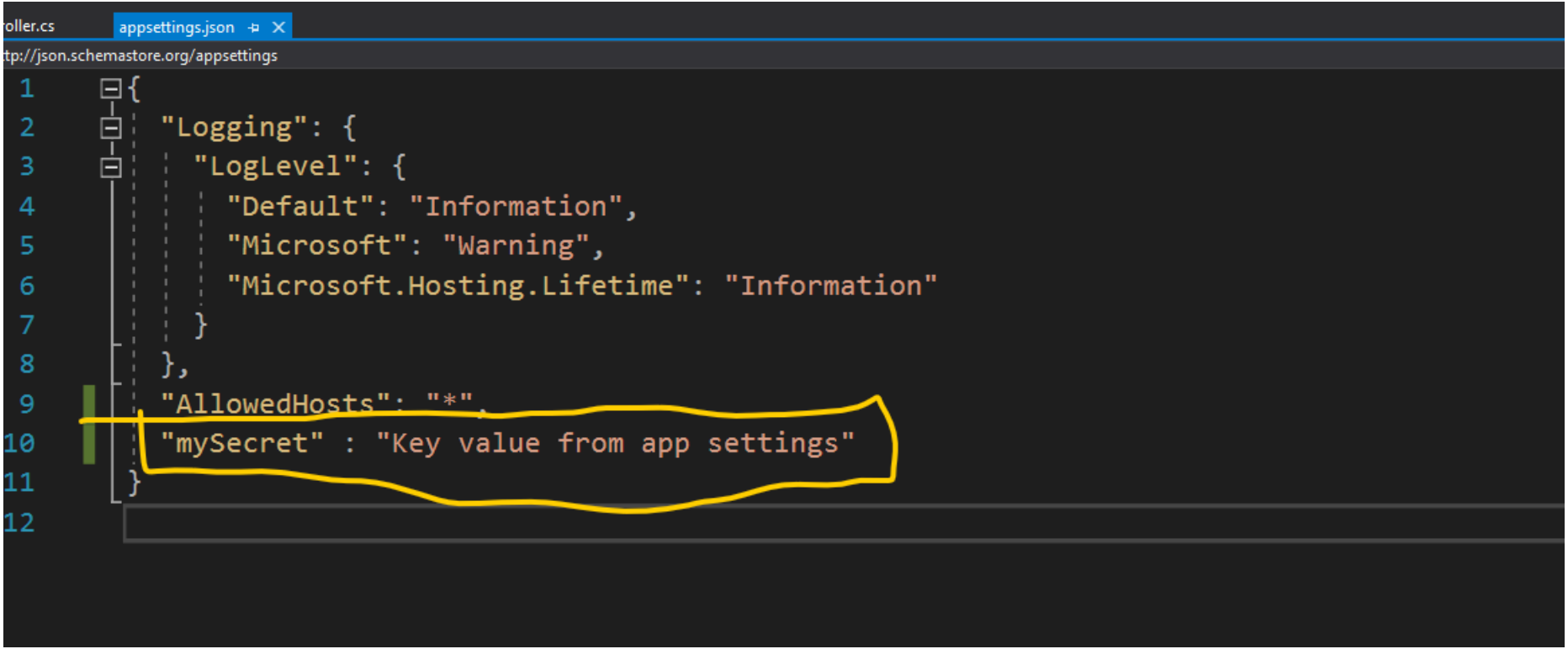
Credential-free Code

Credential-free Code

```
try
{
    using (var sqlConnection = new SqlConnection(connectingString))
    {
        var sqlCommand = new SqlCommand("SELECT Country, Capital FROM CountryInfo", sqlConnection);

        var accessToken = (new AzureServiceTokenProvider()).GetAccessTokenAsync("https://database.windows.net/").Result;
        sqlConnection.AccessToken = accessToken;

        sqlConnection.Open();

        var reader = sqlCommand.ExecuteReader();

        while (reader.Read())
        {
            capitals.Add(reader["Country"].ToString(), reader["Capital"].ToString());
        }

        sqlConnection.Close();
    }
}
```

Key Vault References for App Services and Azure Functions

Key Vault References

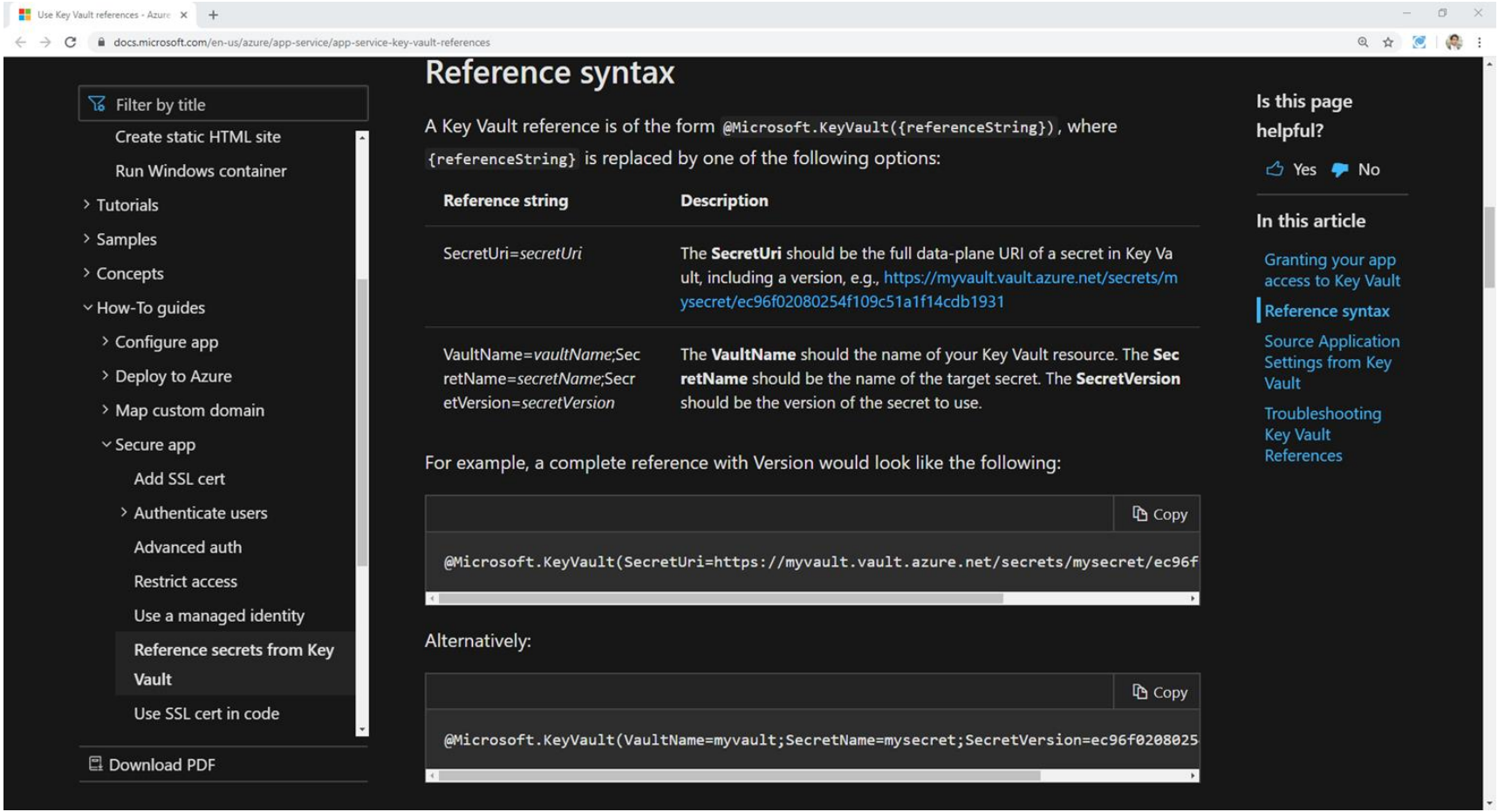


Key Vault References

- Only works for Azure App Services and Azure Functions

Key Vault References

- Only works for Azure App Services and Azure Functions
- Move your app settings to an Azure Key Vault secret
- Reference the KV secret using the special syntax
- No code changes is required


Use Key Vault references - Azure
docs.microsoft.com/en-us/azure/app-service/app-service-key-vault-references
Filter by title
Create static HTML site
Run Windows container
Tutorials
Samples
Concepts
How-To guides
Configure app
Deploy to Azure
Map custom domain
Secure app
Add SSL cert
Authenticate users
Advanced auth
Restrict access
Use a managed identity
Reference secrets from Key Vault
Use SSL cert in code
Download PDF
Reference syntax
A Key Vault reference is of the form @Microsoft.KeyVault({referenceString}), where {referenceString} is replaced by one of the following options:
Reference string
Description
SecretUri=secretUri
The SecretUri should be the full data-plane URI of a secret in Key Vault, including a version, e.g., https://myvault.vault.azure.net/secrets/mysecret/ec96f02080254f109c51a1f14cdb1931
VaultName=vaultName;SecretName=secretName;SecretVersion=secretVersion
The VaultName should the name of your Key Vault resource. The SecretName should be the name of the target secret. The SecretVersion should be the version of the secret to use.
For example, a complete reference with Version would look like the following:
Copy
@Microsoft.KeyVault(SecretUri=https://myvault.vault.azure.net/secrets/mysecret/ec96f
Alternatively:
Copy
@Microsoft.KeyVault(VaultName=myvault;SecretName=mysecret;SecretVersion=ec96f0208025
Is this page helpful?
Yes
No
In this article
Granting your app access to Key Vault
Reference syntax
Source Application Settings from Key Vault
Troubleshooting Key Vault References

Protecting Secrets in Code

1. Azure Key Vault
2. Managed Service Identity
3. Azure Key Vault References

Q&A

Break (5 minutes)

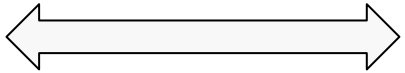
Securing Communications

SSL & TLS

Securing Communications

Securing Communications

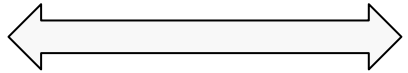
Brower



Server
Apps

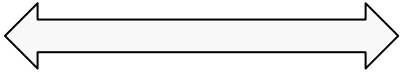
Securing Communications

Brower



Server
Apps

Azure
Funcs



Database

Securing Communications

Brower

Server Apps

Azure Funcs

Database

Server Apps

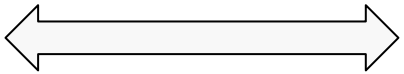
Key Vault

Securing Communications

- All communications should be protected
  - Client to server
  - Server to server
  - Process to process
- SSL/TLS is the main technology used to protect communications
  - Encrypts the packets at the source
  - Decrypts the packets at the destination
  - Public and private keys are used

Securing Communications (SSL)

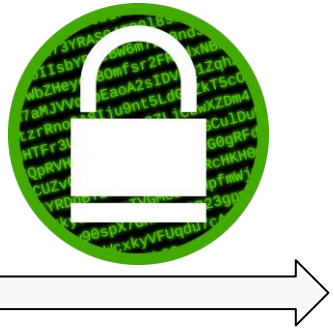
Brower



Server
Apps

Securing Communications (SSL)

Brower



Server
Apps

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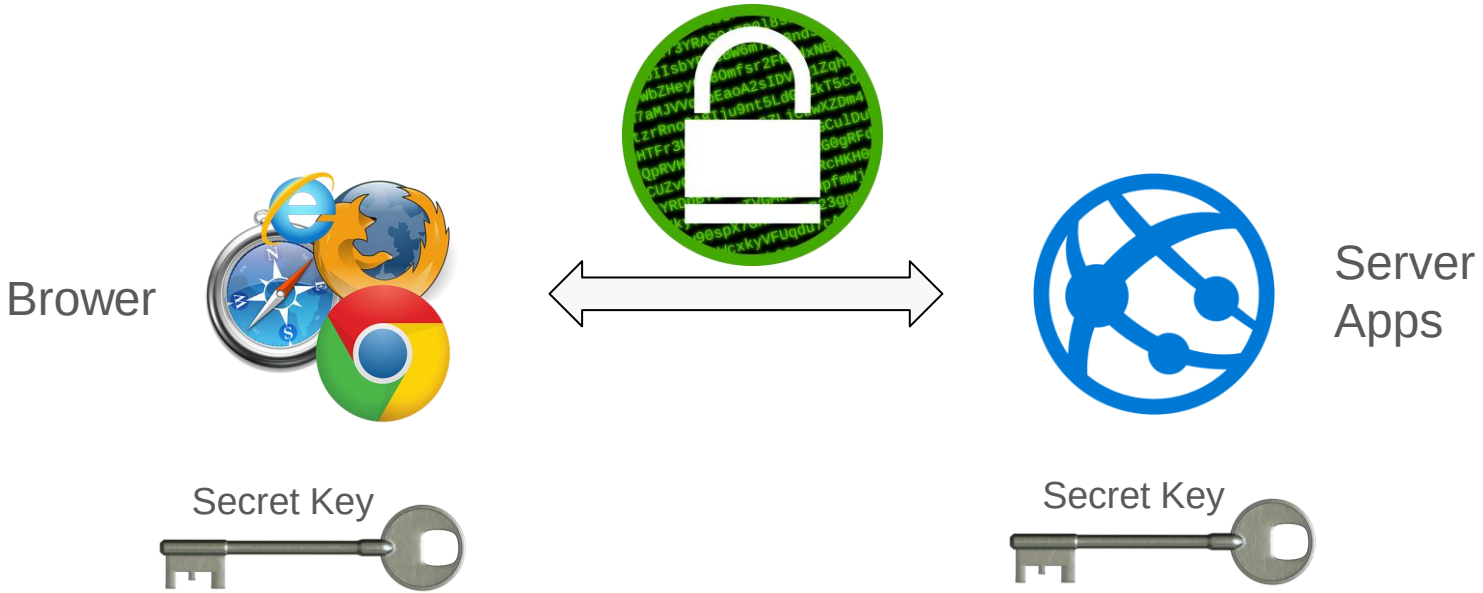

Securing Communications (SSL)

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- SSL protocol is deprecated
- Transport Layer Security (TLS) has replaced it
  - TLS 1.0, 1.1, 1.2 & 1.3
- Microsoft Azure

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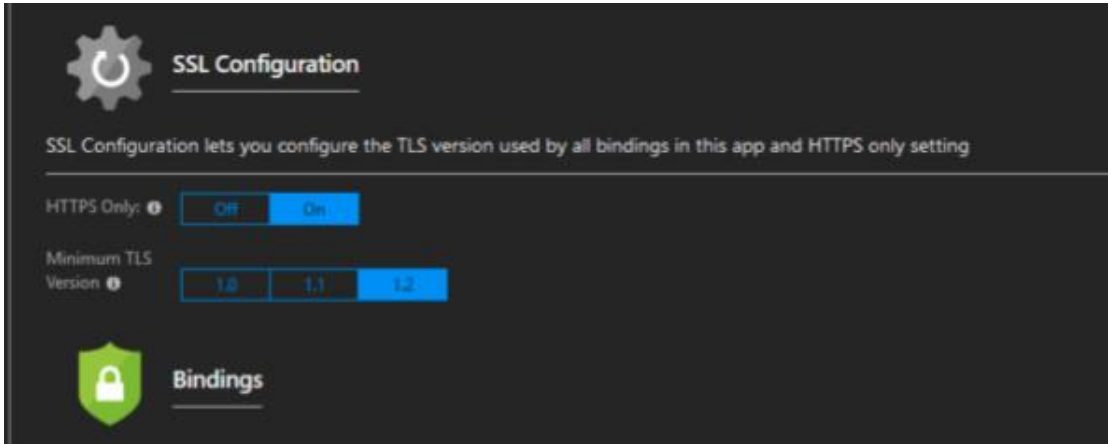
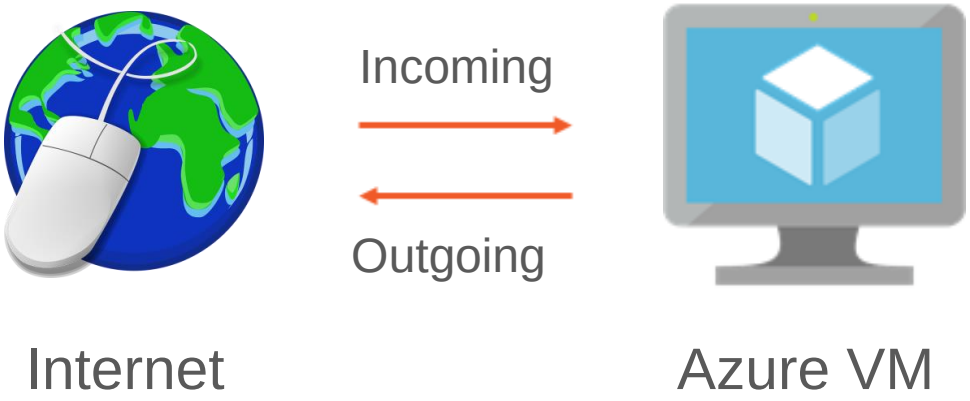


Protecting Virtual Machines

Network Security Groups (NSGs) & ASGs

Protecting virtual machines (NSGs)



Protecting virtual machines (NSGs)

Internet

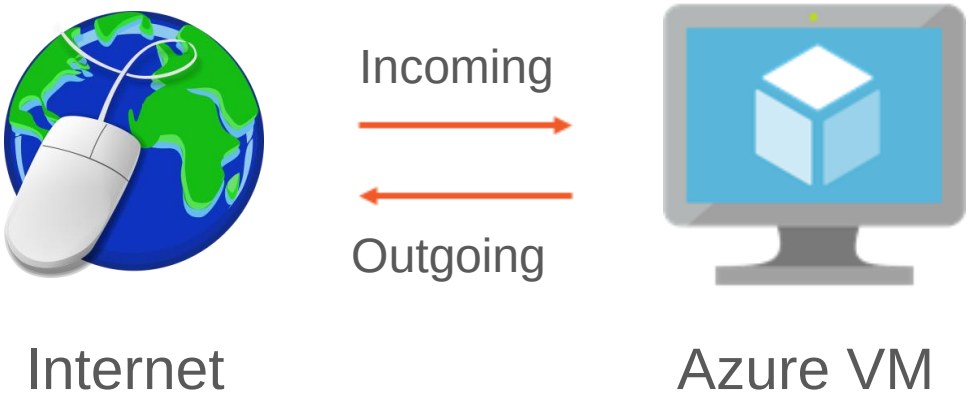
Incoming

Outgoing

Azure VM

- Unprotected TCP ports:
  - 3389
  - 22
  - 80
  - 443
  - 25, 465
- Any IP is allowed
- Incoming & outgoing

Protecting virtual machines (NSGs)



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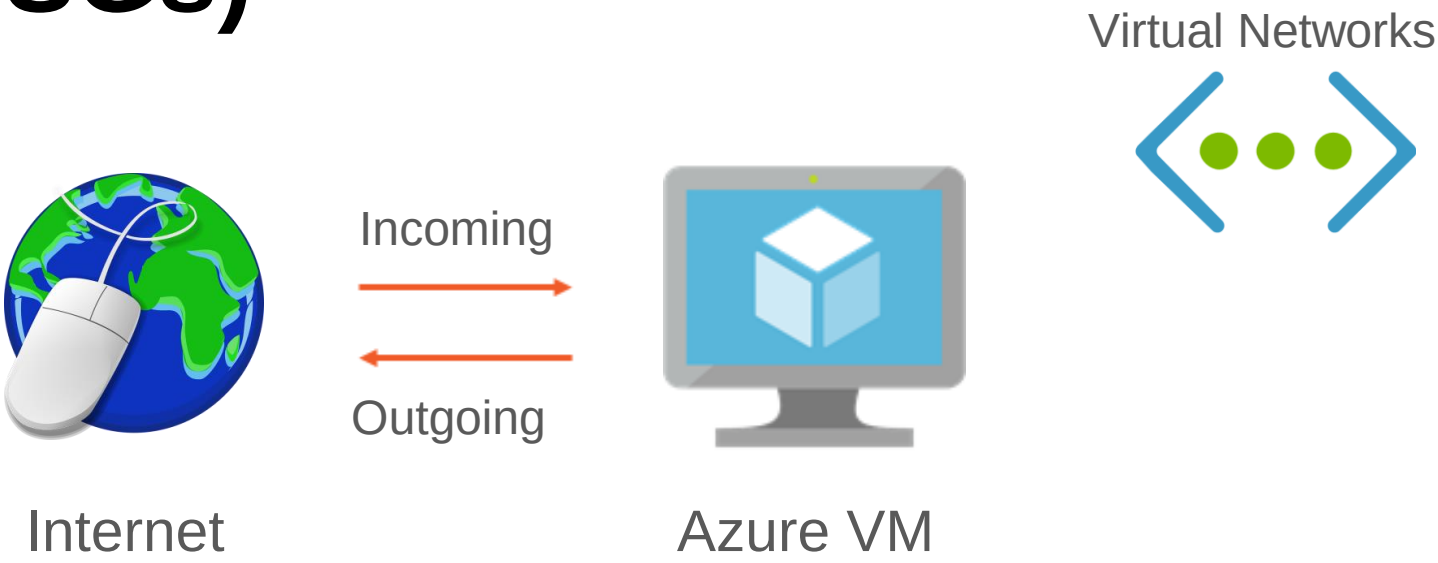

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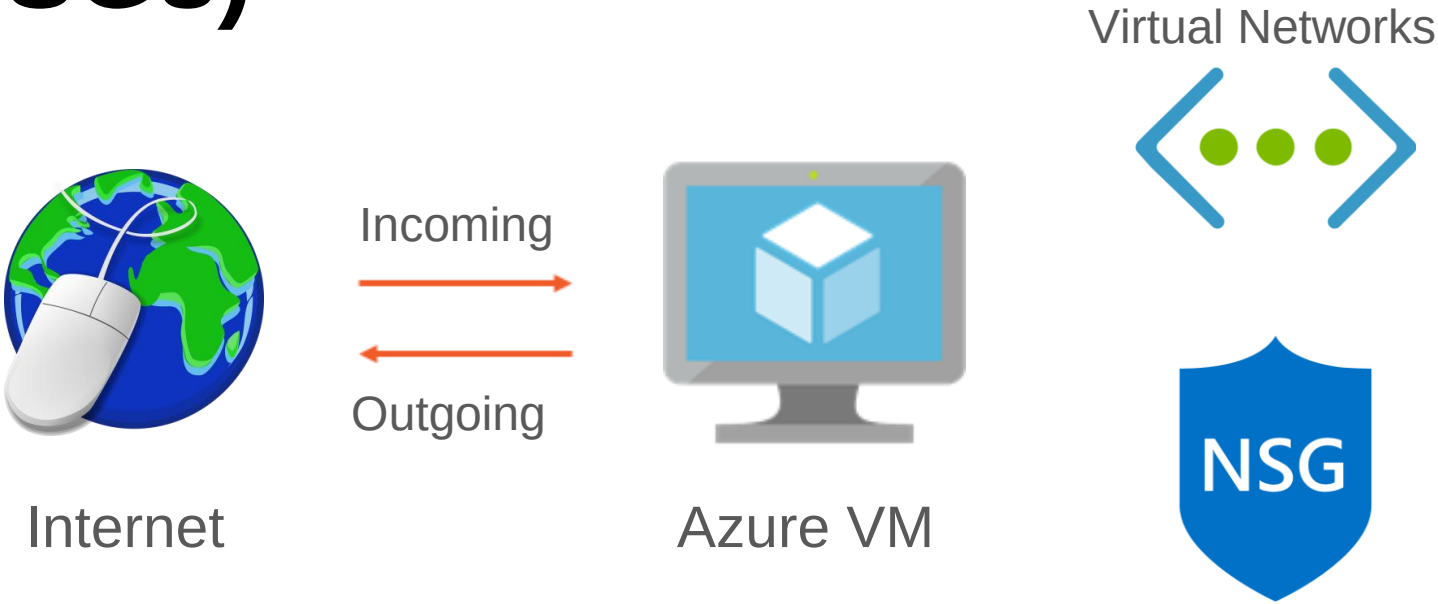
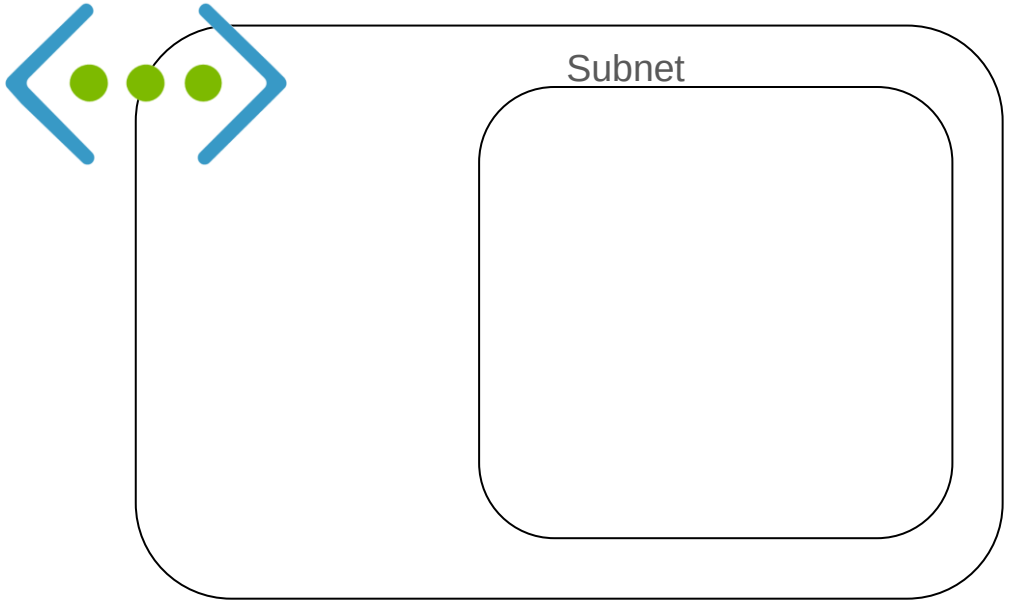


Protecting virtual machines (NSGs)

Protecting virtual machines (NSGs)

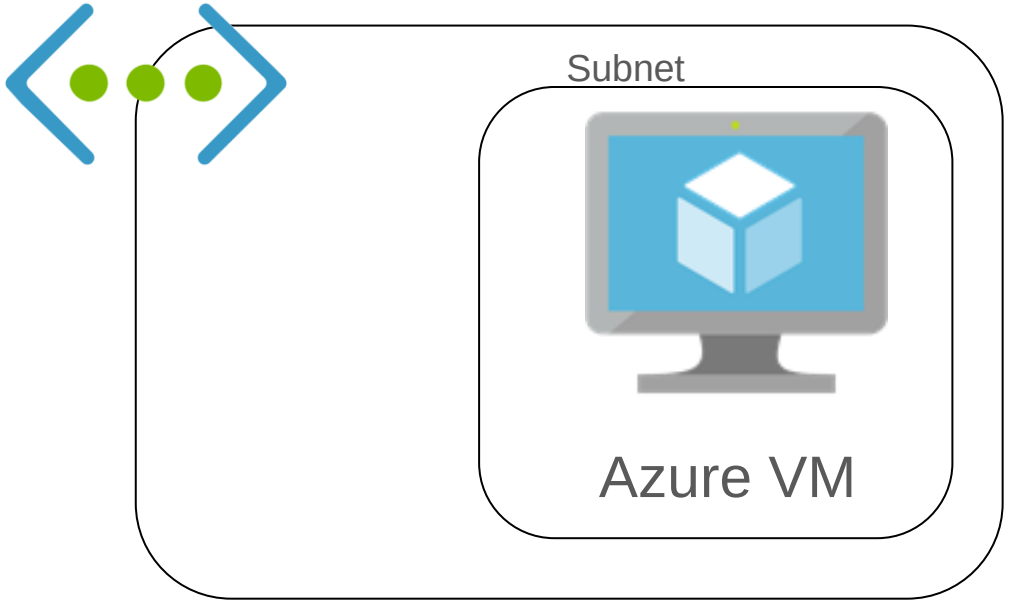
1. Create a VN

Protecting virtual machines (NSGs)



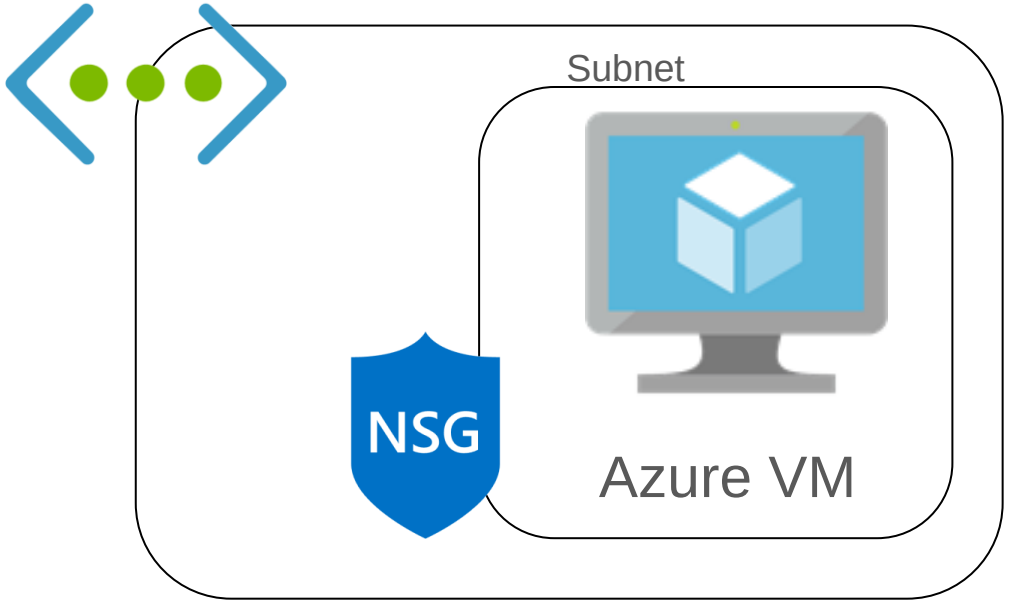
1. Create a VN
2. Add a subnet to VN

Protecting virtual machines (NSGs)



1. Create a VN
2. Add a subnet to VN
3. Add your VM to the subnet

Protecting virtual machines (NSGs)



1. Create a VN
2. Add a subnet to VN
3. Add your VM to the subnet
4. Assign NSG to the subnet

Protecting virtual machines (NSGs)

- Network Security Groups (NSGs)

Protecting virtual machines (NSGs)

- Network Security Groups (NSGs)
  - Filter network traffic to and from Azure resources
    - Using security rules
      - Inbound
      - Outbound
    - Security rules have priorities
      - Lower priority number overrides higher numbers

Security Rules - Inbound

Inbound

AllowVNetInBound

Priority	Source	Source ports	Destination	Destination ports	Protocol	Access
65000	VirtualNetwork	0-65535	VirtualNetwork	0-65535	Any	Allow

AllowAzureLoadBalancerInBound

Priority	Source	Source ports	Destination	Destination ports	Protocol	Access
65001	AzureLoadBalancer	0-65535	0.0.0.0/0	0-65535	Any	Allow

DenyAllInbound

Priority	Source	Source ports	Destination	Destination ports	Protocol	Access
65500	0.0.0.0/0	0-65535	0.0.0.0/0	0-65535	Any	Deny

Security Rules - Inbound

Inbound

AllowVNetInBound

Priority	Source	Source ports	Destination	Destination ports	Protocol	Access
65000	VirtualNetwork	0-65535	VirtualNetwork	0-65535	Any	Allow

AllowAzureLoadBalancerInBound

Priority	Source	Source ports	Destination	Destination ports	Protocol	Access
65001	AzureLoadBalancer	0-65535	0.0.0.0/0	0-65535	Any	Allow

DenyAllInbound

Priority	Source	Source ports	Destination	Destination ports	Protocol	Access
65500	0.0.0.0/0	0-65535	0.0.0.0/0	0-65535	Any	Deny

Security Rules - Inbound

Inbound

AllowVNetInBound

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65001	AzureLoadBalancer	0-65535	0.0.0.0/0	0-65535	Any	Allow

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65500	0.0.0.0/0	0-65535	0.0.0.0/0	0-65535	Any	Deny

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AllowVNetInBound

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Security Rules - Outbound

Outbound

AllowVnetOutBound

Priority	Source	Source ports	Destination	Destination ports	Protocol	Access
65000	VirtualNetwork	0-65535	VirtualNetwork	0-65535	Any	Allow

AllowInternetOutBound

Priority	Source	Source ports	Destination	Destination ports	Protocol	Access
65001	0.0.0.0/0	0-65535	Internet	0-65535	Any	Allow

DenyAllOutBound

Priority	Source	Source ports	Destination	Destination ports	Protocol	Access
65500	0.0.0.0/0	0-65535	0.0.0.0/0	0-65535	Any	Deny

Security Rules - Outbound

Outbound

AllowVnetOutBound

Priority	Source	Source ports	Destination	Destination ports	Protocol	Access
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Priority	Source	Source ports	Destination	Destination ports	Protocol	Access
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65500	0.0.0.0/0	0-65535	0.0.0.0/0	0-65535	Any	Deny

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Priority	Source	Source ports	Destination	Destination ports	Protocol	Access
65500	0.0.0.0/0	0-65535	0.0.0.0/0	0-65535	Any	Deny

Security Rule Properties

Security Rule Properties

1. Name
2. Priority (100-4096)
3. Source / Destination (IP, IP range or service tag)
4. Protocol (TCP, UDP, Any)
5. Direction (Inbound, Outbound)
6. Port (Single or range)
7. Access (Allow, Deny)

Q&A

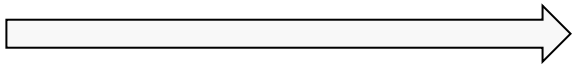
Break (5 minutes)

Protecting Web Applications

Azure Web Application Firewall (WAF)

Protecting web applications against common attacks (WAF)

Internet



App Services

Protecting web applications against common attacks (WAF)

Internet

SQL injection
XSS
Session hijacking

App Services

Protecting web applications against common attacks (WAF)

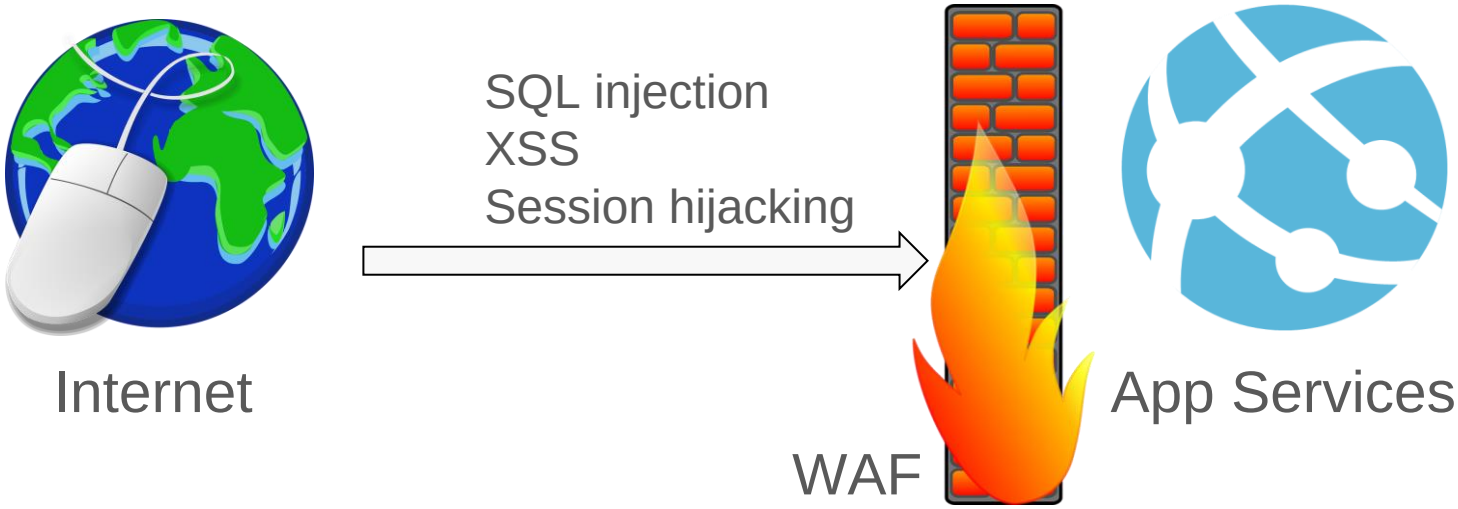
Internet

SQL injection
XSS
Session hijacking

Deal with the attacks at the code level

App Services

Protecting web applications against common attacks (WAF)



Protecting web applications against common attacks (WAF)

Protecting web applications against common attacks (WAF)

- SQL-injection
- Cross-site scripting (XSS)
- Remote file inclusion
- Missing HTTP headers
- Bots, crawlers, scanners
- Oversized request

Protecting web applications against common attacks (WAF)

- WAF is NOT a stand-alone Azure service
- You can use WAF with the following:

Protecting web applications against common attacks (WAF)

- WAF is NOT a stand-alone Azure service
- You can use WAF with the following:
    - Azure Application Gateway

Protecting web applications against common attacks (WAF)

- WAF is NOT a stand-alone Azure service
- You can use WAF with the following:
  - Azure Application Gateway
  - Azure Front Door

Azure Application Gateway

Azure Application Gateway

- A web traffic load balancer
- Enables you to manage traffic to your web applications
- WAF is one of its many features
    - Traffic load balancer
    - SSL termination
    - URL-based routing
    - Redirection
    - Session affinity

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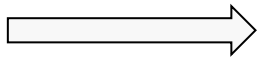
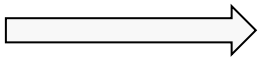
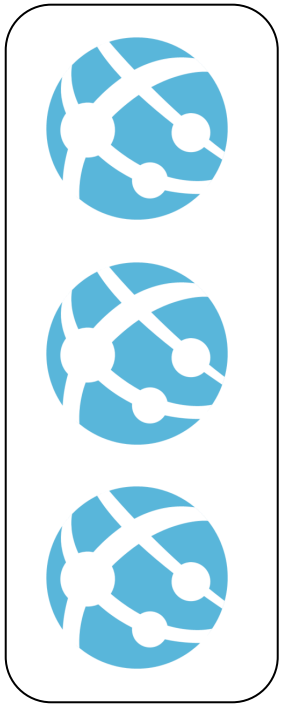
    - **Web application firewall (WAF)**

Azure Application Gateway

Internet

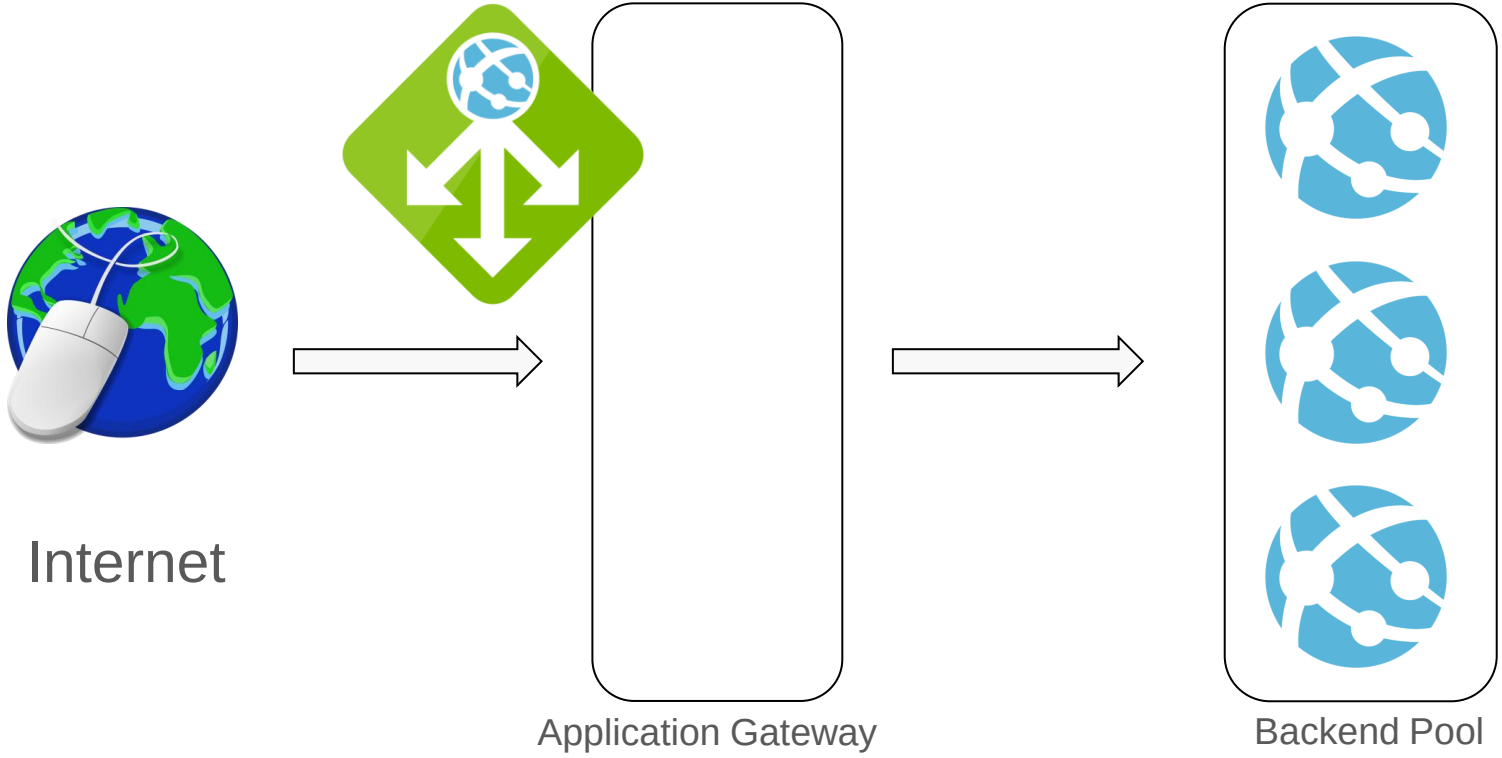




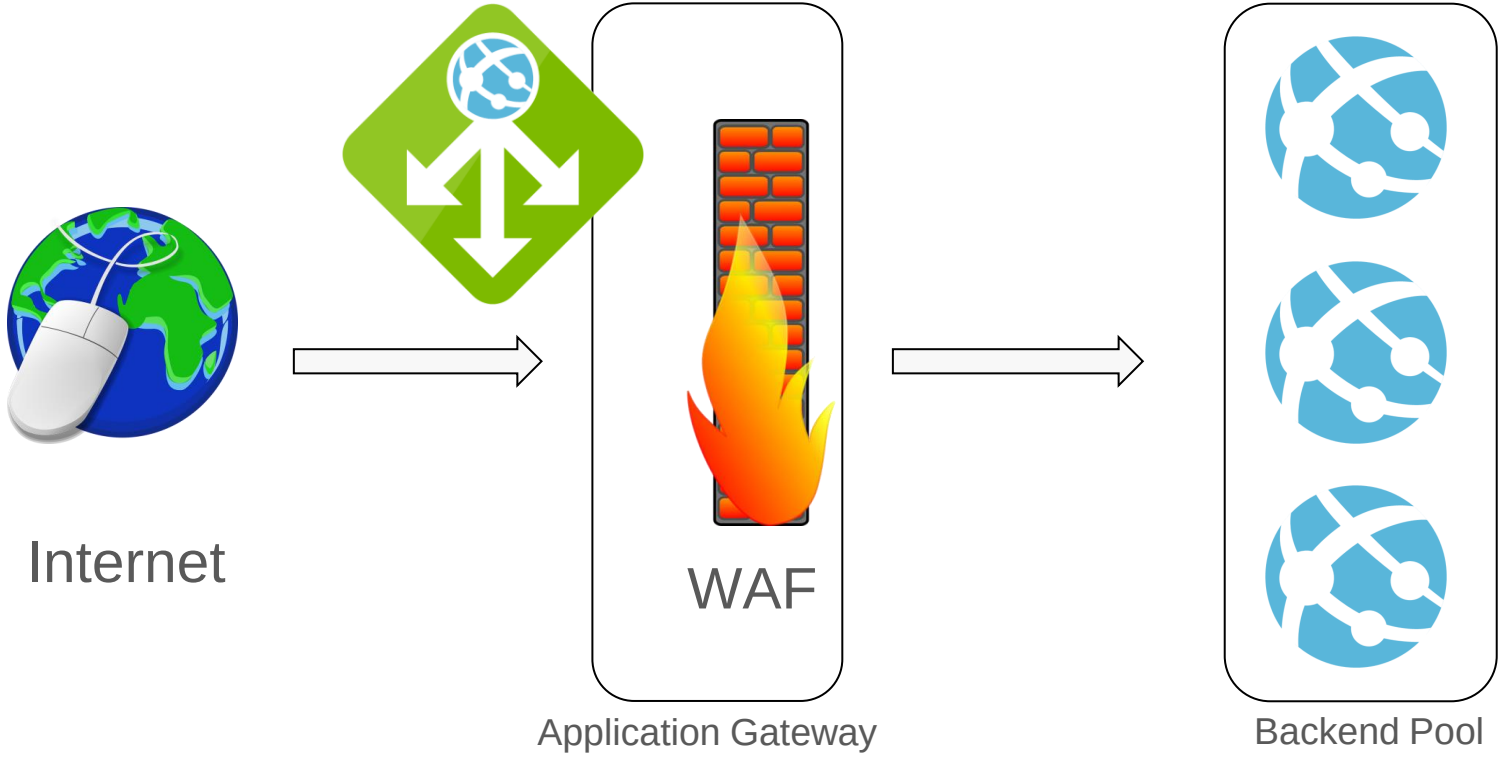


Backend Pool

Azure Application Gateway



Azure Application Gateway



Azure Front Door

Azure Front Door

- A CDN for web applications
- Enables you to optimize your web application traffic
- WAF is one of its many features
    - Accelerates application performance
    - SSL termination
    - URL-based routing
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Azure Front Door

- A CDN for web applications
- Enables you to optimize your web application traffic
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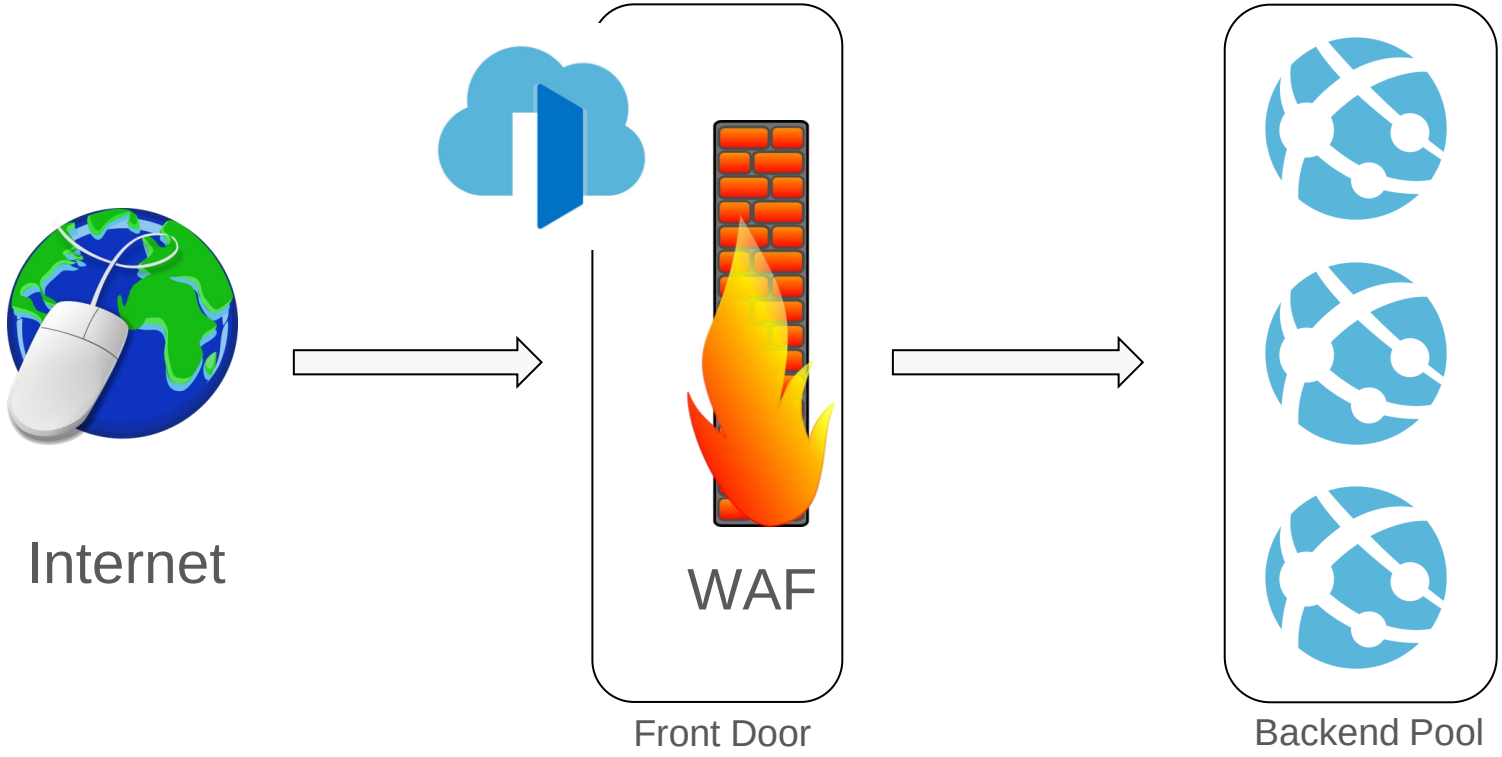
    - Accelerates application performance
    - SSL termination
    - URL-based routing
    - Session affinity
    - **Web application firewall (WAF)**

Azure Front Door



Custom WAF Rules

- WAF v2 comes with a pre-configured ruleset
- Protects against common web attacks
  - XSS, SQL injection, etc.
- Write your own rules if needed

Custom WAF Rules

- WAF v2 comes with a pre-configured ruleset
- Protects against common web attacks
  - XSS, SQL injection, etc.
- Write your own rules if needed
  - Allow traffic from USA
  - Block all requests from IP range xxx.xxx.xxx.xxx/xx
  - etc.

Example 2

You want to allow traffic from the US using the GeoMatch operator:

Azure PowerShell | Copy

```
$variable = New-AzApplicationGatewayFirewallMatchVariable `
   -VariableName RemoteAddr `

$condition = New-AzApplicationGatewayFirewallCondition `
   -MatchVariable $variable `
   -Operator GeoMatch `
   -MatchValue "US" `
   -Transform Lowercase `
   -NegationCondition $False

$rule = New-AzApplicationGatewayFirewallCustomRule `
   -Name "allowUS" `
   -Priority 2 `
   -RuleType MatchRule `
   -MatchCondition $condition `
   -Action Allow
```

And the corresponding JSON:

JSON | Copy

```
{
  "customRules": [
```

custom rules, see Create and use custom web application firewall rules.

Fields for custom rules

Name [optional]

The name of the rule. It appears in the logs.

Priority [required]

- Determines the rule valuation order. The lower the value, the earlier the evaluation of the rule. The allowable range is from 1-100.
- Must be unique across all custom rules. A rule with priority 40 is evaluated before a rule with priority 80.

Rule type [required]

Currently, must be **MatchRule**.

Match variable [required]

Must be one of the variables:

- RemoteAddr – IP Address/hostname of the remote computer connection
- RequestMethod – HTTP Request method (GET, POST, PUT, DELETE, and so on.)
- QueryString – Variable in the URI
- PostArgs – Arguments sent in the POST body. Custom Rules using this match variable are only applied if the 'Content-Type' header is set to 'application/x-www-form-urlencoded' and 'multipart/form-data'.
- RequestUri – URI of the request
- RequestHeaders – Headers of the request
- RequestBody – This contains the entire request body as a whole. Custom rules using this match variable are only applied if the 'Content-Type' header is set to 'application/x-www-form-urlencoded'.

Exam AZ-500

Microsoft Azure Security Technologies

Exam AZ-500

- Skills measured (as of December 4, 2019)
  - Manage identity and access (30–35%)
  - Implement platform protection (15-20%)
  - Manage security operations (25-30%)
  - Secure data and applications (25-30%)

https://query.prod.cms.rt.microsoft.com/cms/api/am/binary/RE3VC70

Exam AZ-500

https://learn.microsoft.com/en-us/certifications/exams/az-500

Exam AZ-500

https://learn.microsoft.com/en-us/certifications/azure-security-engineer/

Course Repository

https://github.com/zaalion/oreilly-azure-app-security

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Thank you!

Reza Salehi

@zaalion