The App-Owns-Data Multitenant Application

The **AppOwnsDataMultiTenant** application is a sample .NET 6 application which demonstrates how to design an application which implements App-Owns-Data embedding using **service principal profiles**. This article explains how to leverage service principal profiles to design and implement a large-scale, multitenant environment for Power BI embedding with 10,000's or 100,000's of customer tenants.

This article will began with a quick primer on developing multitenant application using App-Owns-Data embedding. This primer will allow the reader to better understand the problems that service principal profiles were created to solve. Next, this article will introduce service principal profiles and explain how they can be used to improve performance, scalability and security in a multitenant application that has been developed using App-Owns-Data embedding. The second half of this article contains step-by-step instructions to set up the **AppOwnsDataMultiTenant** application to get it up and running on your developer workstation.

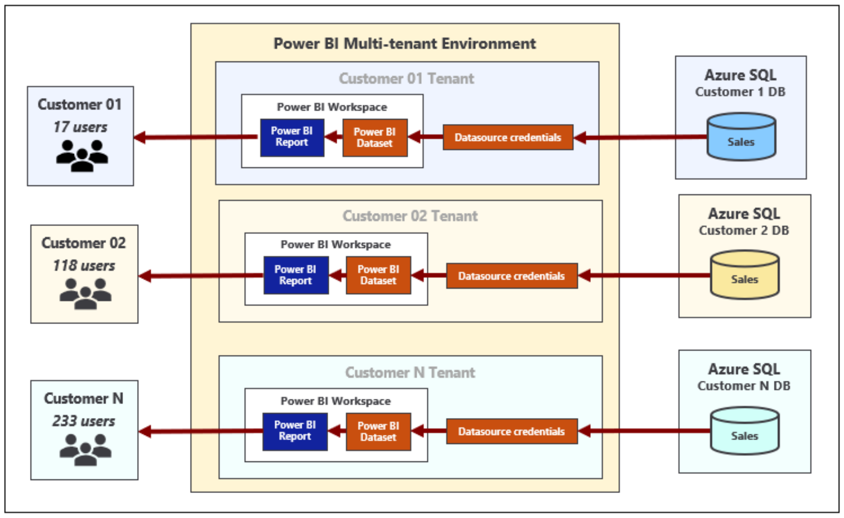
Published March 31, 2022

Table of Contents

Developing Multitenant Applications with Power BI Embedding

If you have experience working with Azure AD, the word **"tenant"** might make you think of an Azure AD tenant. However, the concept of a tenant is different when talking about building a multitenant environment for Power BI embedding. In this context, each tenant is created on behalf of a customer for which you are embedding Power BI reports using the App-Owns-Data embedding model. Each customer tenant is typically implemented using a single Power BI workspace.

In order to create a scalable multitenant environment, you must be able to automate the creation of new customer tenants. Provisioning a new customer tenant typically involves writing code which calls the Power BI REST API to create a new Power BI workspace, import PBIX files, update datasource parameters, set datasource credentials and start dataset refresh operations. The following diagram depicts how Power BI artifacts such as reports and datasets can be added into workspaces to create customer tenants.



When developing an application that implements App-Owns-Data embedding, it's possible to call the Power BI REST API under the identity of a master user account or under the identity of a service principal. However, Microsoft strongly recommends using a service principal.

By using a service principal, you can avoid common problems associated with master user accounts such as experiencing authentication errors in environments where users are required to log in using multi-factor authentication (MFA). Using a service principal is also consistent with the idea that App-Owns-Data embedding is based on leveraging the Power BI Service using a Platform-as-a-Service (PaaS) mindset as opposed to a Software-as-a-Service (SaaS) mindset.

Understanding the 1000 Workspace Limitation

When designing a multitenant environment for App-Owns-Data embedding, there is a documented limitation that requires your attention. In particular, the limitation is that neither a user nor a service principal can be member of more than 1000 workspaces. The purpose of this limitation has to do with performance. The limitation exists to ensure code paths don't become inefficient resulting in performance degradation. A little background might make it easier for you to understand what's involved.

Behind the scenes, the Power BI Service maintains a set of security-related metadata for each service principal. The Power BI Service uses this metadata to track which workspaces and artifacts the service principal can access. In effect, the Power BI Service maintains a separate access control list (ACL) for each service principal as part of its authorization subsystem.

When a service principal calls the Power BI REST API to access a workspace, the Power BI service runs a security check against the service principal's ACL to ensure it has the proper authorization. As you can imagine, the time it takes to determine whether the target workspace ID is inside the ACL increases as the number of workspaces increases. The Power BI team created and documented the 1000-workspace limitation to ensure the authorization metadata (i.e. ACL) for a service principal (or user) doesn't grow so large that it significantly degrades performance.

The 1000-workspace limitation isn’t enforced through code in the Power BI Service. If you try, you'll find you can create 1,200 workspaces using a single service principal. When you cross over the line from 1000 to 1001 workspaces, nothing really changes. Calls from the service principal to the Power BI REST API will still execute successfully. However, it's important to acknowledge that the application has moved into an "unsupported" state which has implications when trying to get help from Microsoft support.

To summarize, the scenario in which a service principal owns 1000 workspaces or less is supported. The scenario in which a service principal owns 1001 workspaces or more is unsupported. However, that's not the end of the story. Let's look at a simple example to make an important point.

Consider a scenario in which two multi-tenant applications have each been implemented to use a single service principal. Now imagine the first application has created 990 workspaces while the second application has created 1010 workspaces. From a supportability standpoint, the first application is within the supported boundaries while the second application is not.

Now let's compare these two applications purely from a performance point of view. There's really not that much difference because the ACLs for both service principals have let the metadata for their ACLs grow to a point where it will degrade performance to some degree.

Here's the key observation. The number of workspaces created by a service principal has a direct effect on performance. A service principal which is a member of 100 workspaces will execute calls on the Power BI REST API faster than a service principal which is a member of 1000 workspaces. Likewise, a service principal which is a member of only 10 workspaces will execute calls faster than a service principal which is a member of 100 workspaces. From the perspective of performance and scalability, the optimal number of workspaces in which a service principal should be a member is 1.

Managing Isolation for Datasets and Datasource Credentials

Another important aspect of designing an App-Owns-Data embedding application for a multitenant environment has to do with maintaining the required level of isolation across customer tenants. The last thing you want is for a user from one customer tenant to see data from another tenant that belongs to a different customer. Therefore, it's critical that you understand how datasets and datasource credentials are managed within the Power BI Service.

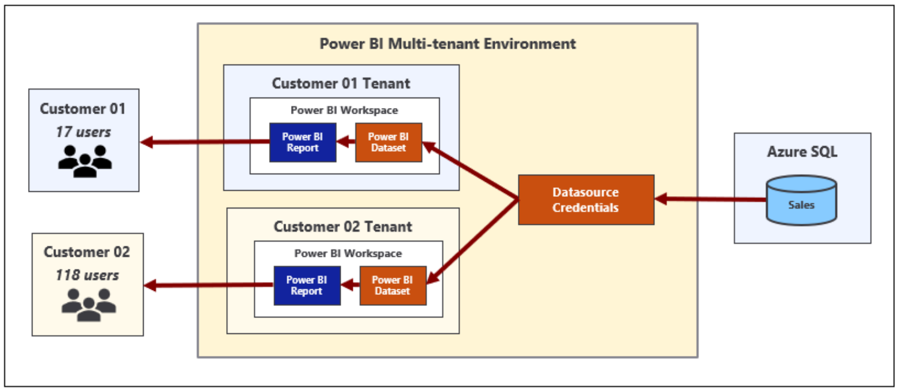
Each dataset in the Power BI Service has an owner which can be either a user or a service principal. You can discover who the dataset owner is by inspecting the **ConfiguredBy** property in the dataset settings page.

If it's ever required, you can perform a Take Over action to transfer dataset ownership from one user or service principal to another. If you import a PBIX file to create a new dataset using a service principal, the service principal is automatically configured as the dataset owner.

In order to connect a dataset to its underlying datasource, the dataset owner must set dataset credentials. These datasource credentials are then cached by the Power BI Service in an encrypted fashion. After that point, the Power BI Service is then able to use those credentials to authenticate with the underlying datasource when refreshing the data in an import-mode dataset or when executing a query with a DirectQuery dataset.

There is a common pattern used when provisioning a new customer tenant where the application executes a series of calls running under the identity of a service principal. The first call creates a new workspace. The second call associates that workspace with a dedicated capacity. Next, there is a call to import a PBIX file to create a new dataset. After importing a PBIX file to create a dataset, a service principal can then set the dataset source credentials for that dataset. As a result of these Power BI REST API calls, the service principal is an Admin of the new workspace and the owner of the dataset and the datasource credentials.

A common misconception is that datasource credentials in the Power BI Service are scoped at the workspace level. They are not. Instead, datasource credentials are scoped by user or by service principal and their scope extends across all Power BI workspaces in the current Azure AD tenant. It's possible for a service principal to create datasource credentials that are used by datasets in different workspaces as shown in the following diagram.



Design Strategies Before Service Principal Profiles

In this section, we will quickly review the three common design strategies that have been used to build and manage multitenant environments for App-Owns-Data embedding. This will give you a better appreciation of the design problems that service principal profiles have been designed to solve.

Prior to the introduction of service principal profiles, developers have built multitenant applications with support for App-Owns-Data embedding using one the following three design strategies.

- Single service principal
- Service principal pooling
- One service principal per workspace

Now let's review the strengths and weakness of each of these design strategies starting with single service principal. When an application is designed to use a single service principal, it requires a one-time creation of Azure AD application for service principal. Therefore, it requires less administrative overhead than the other two strategies because there is no ongoing need to create new Azure AD applications in order to add more service principals. It is also the easiest strategy to implement as the other two strategies require extra code to switch the calling context between service principals when calling the Power BI REST API.

The obvious problem with the single service principal design strategy is it doesn't scale. It only supports a multitenant environment that can grow to no larger than 1000 workspaces. The application will also be less performant as the service principal becomes a member of a large number of workspaces. Finally, there is a problem with customer tenant isolation because there is a single service principal that will be the owner of every dataset and all data credentials across all customer tenants.

Service principal pooling provides a commonly-used strategy to get around the 1000-workspace limitation. The main idea is that the application can scale to any number of required workspaces by adding the correct number of service principals to the pool. For example, a pool of 5 service principals makes it possible to scale up to 5,000 workspaces. A pool of 80 service principals makes it possible to scale up to 80,000 workspaces.

While service principal pooling can scale to a large number of workspaces, it has several disadvantages. First, it requires extra code and metadata to implement context switching between service principals when calling the Power BI REST API. Second, there is more administrative overhead as it will be necessary to create new Azure AD applications whenever it's necessary to increase the number of the service principals in the pool.

The service principal pooling strategy is not optimized for performance because it allows service principals to become members of 100s of workspaces. It also is not ideal from the perspective of customer tenant isolation. While it's slightly better than the single service principal strategy, there is still the issue where each service principal will the owner of datasets and datasource credentials across many different customer tenants which compromises isolation.

The final strategy is the one that involves creating a new service principal for each new customer tenant. From a theoretical standpoint, this is the best solution because it optimizes the performance of calls to the Power BI REST API while also providing true isolation for datasets and datasource credentials at the workspace level. However, what works best in theory doesn't always work best in practice. This is a good example.

The strategy of creating a new service principal for each new customer tenant is impractical for most large organizations. That's because these organizations require formal approval processes or they introduce other bureaucratic red tape for creating new Azure AD applications. This makes it impossible to grant a custom application the authority it needs to create new Azure AD applications on-demand in an automated fashion which is a requirement when using this strategy.

In less-common scenarios where a custom application is granted the proper permissions, it can use the Microsoft Graph API to create new Azure AD applications on demand. This type of custom application becomes more complex to develop and deploy because it must somehow track authentication credentials for each Azure AD application and gain access to those credentials whenever it needs to authenticate and acquire access tokens for individual service principals. The TenantManagement sample application demonstrates using this approach.

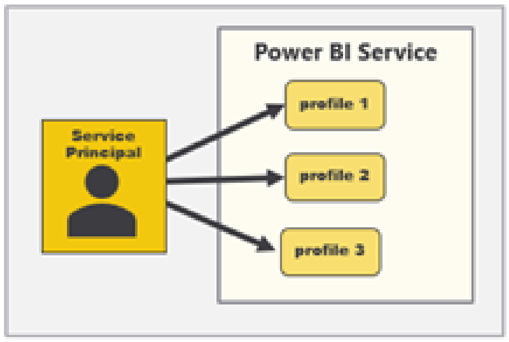
Introduction to Service Principal Profiles

The previous section discussed three essential problems that need to be addressed when developing a multitenant application that uses App-Owns-Data embedding. Here is a summary of those three problems.

1. Scaling to a large number of workspaces
2. Optimizing performance in calls to the Power BI REST API
3. Isolating datasets and datasource credentials at the customer tenant level.

The Power BI embedding team created the service principal profiles feature to solve these three problems with the lowest amount of developer effort and overhead. As you will see, designing a multitenant application using service principal profiles will combine the strengths of the three design strategies discussed in the previous section while avoiding the weaknesses. Now it's time to drill down into a discussion about how service principal profiles work.

Service principal profiles are local accounts which are created within the context of the Power BI Service. A service principal can use the new Profiles endpoint of the Power BI REST API to create new service principal profiles. This makes it possible for a service principal to create and manage its own set of service principal profiles for a custom application as shown in the following diagram.

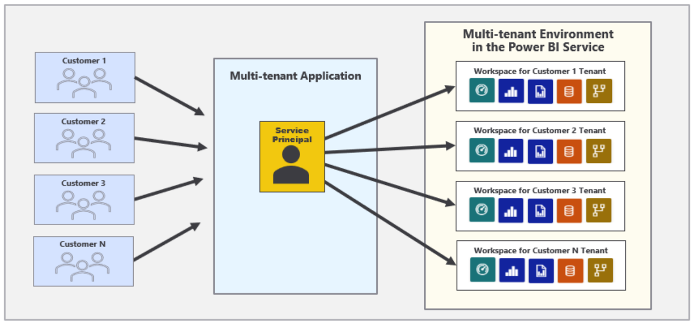


Later in this article, you will learn how to write code to create service principal profiles as well as how to execute Power BI REST API calls under the identity of a service principal profile. However, it's now time to make a general observation. While the service principal itself and its underlying Azure AD application are known to Azure AD, Azure AD doesn't know anything about service principal profiles. Instead, service principal profiles are created by the Power BI Service and they only exist within the context of the Power BI Service subsystem which controls security and authorization.

There will always be a parent-child relationship between a service principal and the service principal profiles it creates. A service principal profile can never be created as a stand-alone entity. Instead, each service principal profile must be created by specific service principal and that service principal will serve as the profile's parent. Furthermore, a service principal is never visible to users or other service principals. A service principal profile can only be seen and used by the service principal that created it.

Service Principal Profiles as First-class Power BI Security Principals

The second important observation is that a service principal profile is first-class security principal in the Power BI authorization system. The Power BI Service treats a service principal profile like a user or a service principal in the sense that a profile can be added to a workspace as a member. A service principal profiles can also be the owner of a dataset and the owner of datasource credentials. This leads to the best practice of creating a new service principal profile for each new customer tenant as shown in the following diagram.


Customer 1
Customer 2
Customer 3
Customer N
Multi-tenant Application
Service Principal
Multi-tenant Environment in the Power BI Service
Workspace for Customer 1 Tenant
Workspace for Customer 2 Tenant
Workspace for Customer 3 Tenant
Workspace for Customer N Tenant

When you develop a custom application using service principal profiles, you only need a single Azure AD application which provides your application with a single service principal. This lowers administrative overhead compared to previous strategies because there is no ongoing need to create additional Azure AD applications after the application goes into production.

Executing Power BI REST API Calls as a Service Principal Profile

You can execute Power BI REST API calls under the identity of a service principal profile. That means you can execute the sequence of API calls under the identity of a service principal profile when provisioning a new customer tenant. Let's examine this idea in a little more detail.

If you execute a Power BI REST API call under the identity of a service principal profile to create a new workspace, that profile will automatically be configured as a workspace member in the role of Admin. If you execute a call under the identity of a service principal profile to import a PBIX file and create a dataset, that profile will be configured as the dataset owner. If you execute call under the identity of a service principal profile to set datasource credentials, the profile will be configured as the owner of the datasource credentials.

Programming with service principal profiles might seem a little complicated at first. You can execute API calls under the identity of a service principal profile and you can also execute API calls without a profile which execute under the identity of the parent service principal. It's important to understand that a service principal has an identity in the Power BI Service that is separate and distinct from the identities of its profiles.

Now let's discuss a common programming pattern when developing a multitenant application using service principal profiles. Start by asking yourself this question. When do you execute Power BI REST API calls as the parent service principal versus when do you execute API calls a child service principal profile? It turns out this isn’t too complicated once you understand the basic programming pattern.

You should execute API calls as the parent service principal when you are creating, viewing and deleting service principal profiles. However, most of the other API calls should be executed as a service principal profile. This includes API calls to create workspaces and import PBIX files. It also includes API calls to update dataset parameters and to set datasource credentials. Finally, it includes API calls to query for workspace artifacts and to generate embed tokens.

Let's walk through a simple example. Imagine you need to create a new customer tenant for a customer named Contoso. The first step is to execute an API call to create a new service principal profile with a display name of Contoso. That first call is made under the identity of the service principal. However, all the remaining Power BI REST API calls shown in the following list should be made under the identity of the service principal profile that has just been created.

- Create workspace
- Associated workspace with capacity
- Import PBIX
- Update dataset parameters
- Set credentials
- Start refresh

Now, let's make one final observation. Each customer tenant is built using a Power BI workspace and a set of artifacts that are all owned and managed by one specific service principal profile. In order to access that Power BI workspace and its content at a later time, you must execute API calls using the identity of the same service principal profile that was used to create the customer tenant.

And what about the service principal itself? Does the service principal require any access to the workspaces for customer tenants and the content inside? The answer is no, the service principal itself doesn't need any access at all. Remember, Power BI REST API calls executed under the identity of the service principal are mainly used to create and manage service principal profiles. API calls for workspace creation and content access are executed as a service principal profile.

Using the Profiles API to create and manage service principal profiles

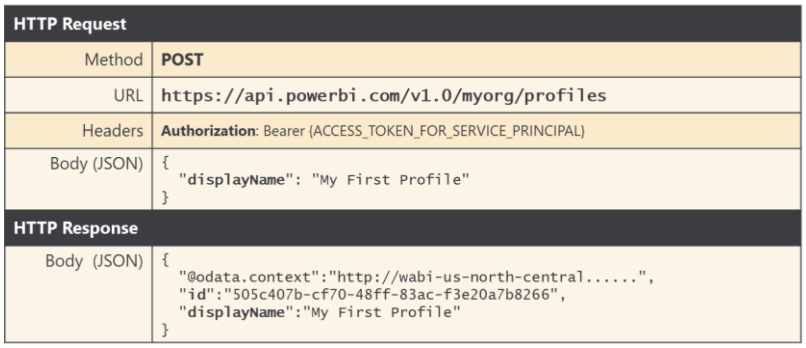
The Power BI embedding team has introduced a new **Profiles** API which is used to create and manage service principal profiles. You can find the documentation for the **Profiles** API at the following URL.

`https://docs.microsoft.com/en-us/rest/api/power-bi/profiles`

The Profiles API contains the following operations.

- Create Profile
- Delete Profile
- Get Profile
- Get Profiles
- Update Profile

Let's begin by looking at the Create Profile operation. The following table shows the details required for executing an HTTP POST request against the **Profiles** endpoint to create a new service principal profile.

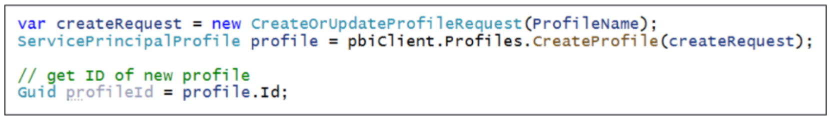


HTTP Request	
Method	**POST**
URL	`https://api.powerbi.com/v1.0/myorg/profiles`
Headers	**Authorization**: Bearer {ACCESS_TOKEN_FOR_SERVICE_PRINCIPAL}
Body (JSON)	`{ "displayName": "My First Profile" }`
HTTP Response	
Body (JSON)	`{ "@odata.context":"http://wabi-us-north-central......", "id":"505c407b-cf70-48ff-83ac-f3e20a7b8266", "displayName":"My First Profile" }`

Note that you must pass a **displayName** property in the request body to provide a display name for the new tenant. The **displayName** must be unique across all the profiles owned by a specific service principal.

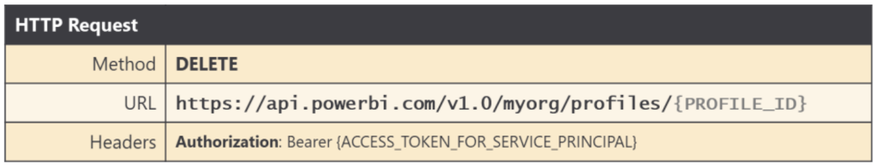
The API call to create a new service principal profile returns an **id** property with a GUID which represents the profile id. When developing applications that use service principal profiles, it's a best practice to store profile display names and ids in a custom database so the application can lookup the id for a service principal profile whenever it's required.

If you are programming with the Power BI .NET SDK, you can call **Profile.CreateProfile** which returns a new **ServicePrinicpalProfile** object which makes it possible to discover the **id** property value of the new profile.



```
var createRequest = new CreateOrUpdateProfileRequest(ProfileName);
ServicePrincipalProfile profile = pbiClient.Profiles.CreateProfile(createRequest);

// get ID of new profile
Guid profileId = profile.Id;
```

When you need to delete a service principal profile, you can execute an HTTP DELETE operation in which the profile id is parsed into the end of the URL.

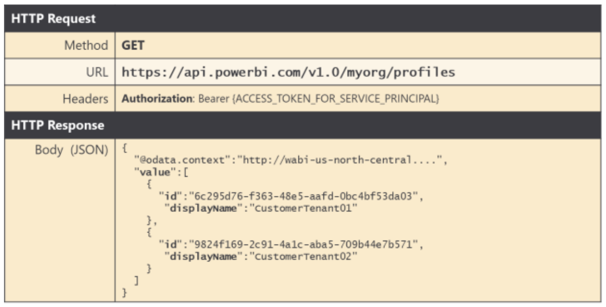


HTTP Request	
Method	**DELETE**
URL	`https://api.powerbi.com/v1.0/myorg/profiles/{PROFILE_ID}`
Headers	**Authorization**: Bearer {ACCESS_TOKEN_FOR_SERVICE_PRINCIPAL}

If you are programming with the Power BI .NET SDK, you can call **Profile.DeleteProfile** using the following code.

```
pbiClient.Profiles.DeleteProfile(new Guid(ProfileId));
```

If you need to query the set of service principal profiles associated with the current service principal, you can execute an HTTP GET operation against the **Profiles** endpoint. This API calls returns a JSON payload with the **id** and **displayName** of each service principal profile.



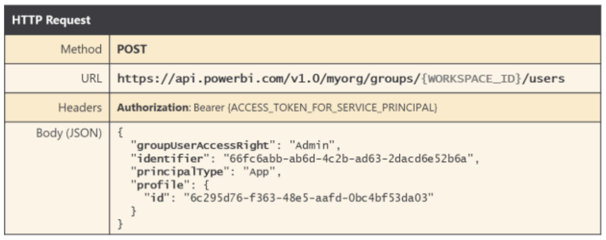
HTTP Request	
Method	**GET**
URL	`https://api.powerbi.com/v1.0/myorg/profiles`
Headers	**Authorization**: Bearer {ACCESS_TOKEN_FOR_SERVICE_PRINCIPAL}
HTTP Response	
Body (JSON)	see below

```
{
  "@odata.context":"http://wabi-us-north-central....",
  "value":[
    {
      "id":"6c295d76-f363-48e5-aafd-0bc4bf53da03",
       "displayName":"CustomerTenant01"
    },
    {
      "id":"9824f169-2c91-4a1c-aba5-709b44e7b571",
       "displayName":"CustomerTenant02"
    }
  ]
}
```

If you are programming with the Power BI .NET SDK, you can call **Profile.GetProfiles** using the following code.

```
IList<ServicePrincipalProfile> profiles = pbiClient.Profiles.GetProfiles().Value;
```

Let's say you've just created a new service principal profile and you'd like to add it as a member of a workspace to give it access. You can execute an HTTP POST operation in which the request body provides the following JSON with an **identifier** property with the service principal object ID and an inner **profile** object with an **id** property that contains the profile Id.



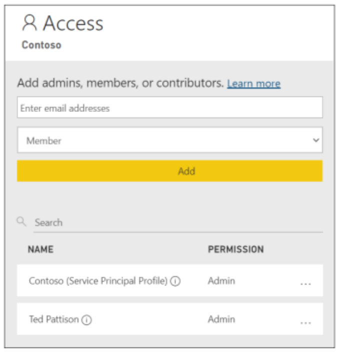
HTTP Request	
Method	**POST**
URL	`https://api.powerbi.com/v1.0/myorg/groups/{WORKSPACE_ID}/users`
Headers	**Authorization**: Bearer {ACCESS_TOKEN_FOR_SERVICE_PRINCIPAL}
Body (JSON)	see below

```
{
  "groupUserAccessRight": "Admin",
  "identifier": "66fc6abb-ab6d-4c2b-ad63-2dacd6e52b6a",
  "principalType": "App",
  "profile": {
    "id": "6c295d76-f363-48e5-aafd-0bc4bf53da03"
  }
}
```

If you are programming with the Power BI .NET SDK, you can use the following code to add a service principal profile as a workspace member in the role of Admin.

```
public void AddProfileAsWorkspaceMember(Guid WorkspaceId, string ServicePrincipalId, Guid ProfileId) {

  var groupUser = new GroupUser {
    GroupUserAccessRight = "Admin",
    PrincipalType = "App",
    Identifier = ServicePrincipalId,
    Profile = new ServicePrincipalProfile {
      Id = ProfileId
    }
  };

  pbiClient.Groups.AddGroupUser(WorkspaceId, groupUser);

}
```

If you inspect the **Access** pane for a Power BI workspace in the Power BI Service, you can determine which accounts have been added as members. The following screenshot shows the Access pane for a workspace whose membership includes a user and a service principal profile with a display name of Contoso.



Access
Contoso

Add admins, members, or contributors. Learn more

Enter email addresses

Member

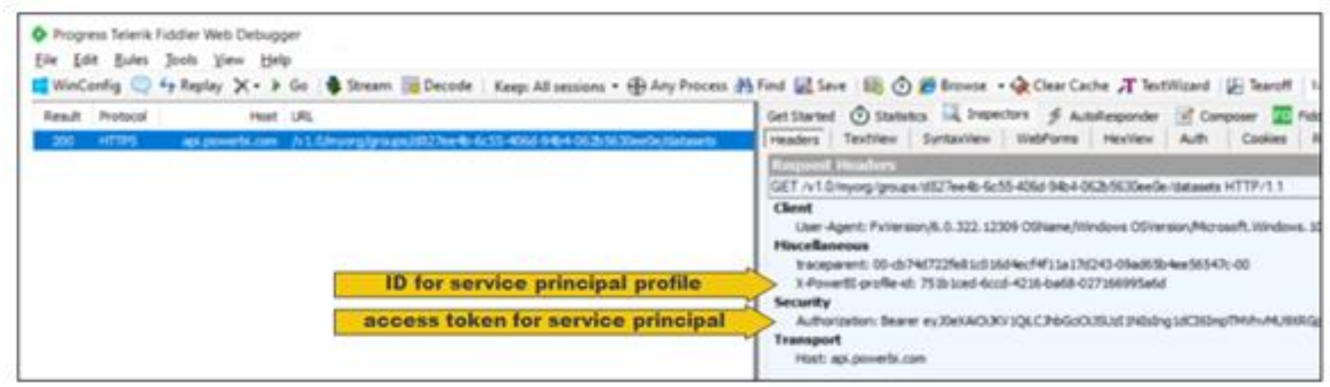
Add

Search

NAME	PERMISSION	
Contoso (Service Principal Profile) ⓘ	Admin	...
Ted Pattison ⓘ	Admin	...

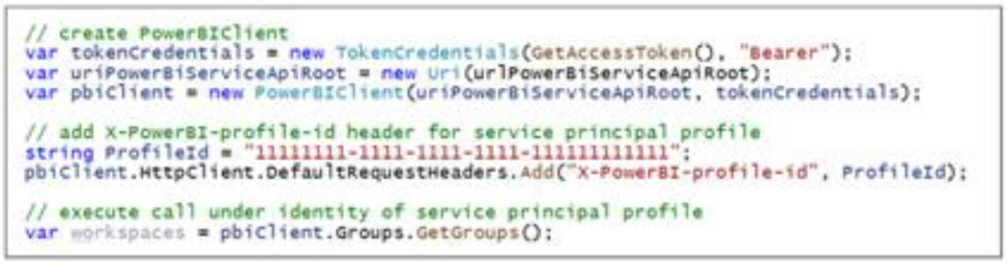
Executing API Calls under the Identity of a Service Principal Profile

There are two requirements for executing Power BI REST API calls under the identity of a service principal profile. First, you need to pass the access token for the parent service principal in the **Authorization** header. Second, you need to include a header named **X-PowerBI-profile-id** with the value for the service principal profile Id.


Progress Telerik Fiddler Web Debugger
File Edit Rules Tools View Help
WinConfig Replay Go Stream Decode Keep: All sessions Any Process Find Save Browse Clear Cache TextWizard Tearoff
Result Protocol Host URL
200 HTTPS api.powerbi.com /v1.0/myorg/groups/d827ee4b-6c55-406d-94b4-062b5630ee0e/datasets
Get Started Statistics Inspectors AutoResponder Composer
Headers TextView SyntaxView WebForms HexView Auth Cookies
ID for service principal profile
access token for service principal

```
Request Headers
GET /v1.0/myorg/groups/d827ee4b-6c55-406d-94b4-062b5630ee0e/datasets HTTP/1.1
Client
    User-Agent: FxVersion/6.0.322.12309 OSName/Windows OSVersion/Microsoft.Windows.1
Miscellaneous
    traceparent: 00-cb74d722fe81c016d4ecf4f11a17d243-09ad65b4ee56547c-00
    X-PowerBI-profile-id: 751b1ced-6ccd-4216-ba68-027166995a6d
Security
    Authorization: Bearer eyJ0eXAiOiJKV1QiLCJhbGciOiJSUzI1NiIsIng1dCI6ImpTMVhvMUJXRG
Transport
    Host: api.powerbi.com
```

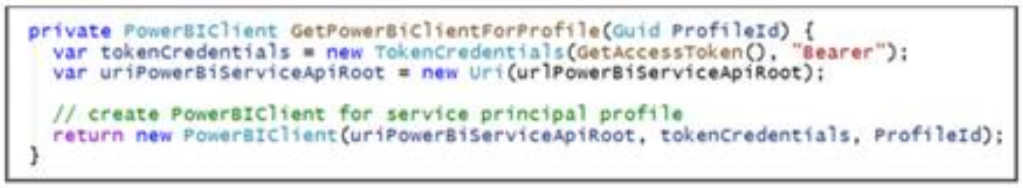
If you are using the Power BI .NET SDK, you can set the **X-PowerBI-profile-id** header value explicitly with the GUID for service principal profile Id using the following code.



```
// create PowerBIClient
var tokenCredentials = new TokenCredentials(GetAccessToken(), "Bearer");
var uriPowerBiServiceApiRoot = new Uri(urlPowerBiServiceApiRoot);
var pbiClient = new PowerBIClient(uriPowerBiServiceApiRoot, tokenCredentials);

// add X-PowerBI-profile-id header for service principal profile
string ProfileId = "11111111-1111-1111-1111-111111111111";
pbiClient.HttpClient.DefaultRequestHeaders.Add("X-PowerBI-profile-id", ProfileId);

// execute call under identity of service principal profile
var workspaces = pbiClient.Groups.GetGroups();
```

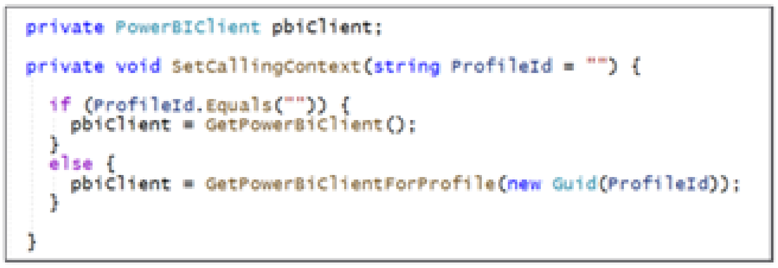
As you can see from the previous code listing, once you have added the **X-PowerBI-profile-id** header to the **PowerBIClient** object, you can just call Power BI REST API operations such as **Groups.GetGroups** as you normally would and the call will be executed under the identity of a service principal profile.

There is a second way to set the **X-PowerBI-profile-id** header for a **PowerBIClient** object. More specifically, you can initialize a **PowerBIClient** object by passing the GUID for a profile id in the constructor using this code.



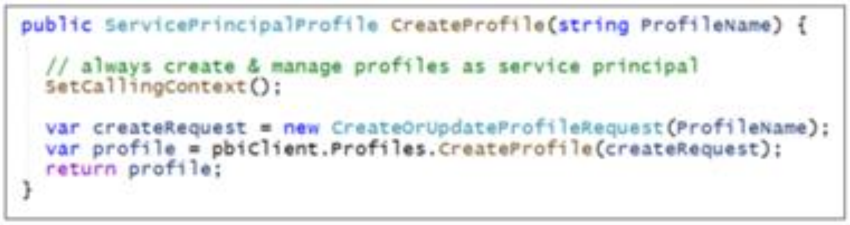
```
private PowerBIClient GetPowerBiClientForProfile(Guid ProfileId) {
  var tokenCredentials = new TokenCredentials(GetAccessToken(), "Bearer");
  var uriPowerBiServiceApiRoot = new Uri(urlPowerBiServiceApiRoot);

  // create PowerBIClient for service principal profile
  return new PowerBIClient(uriPowerBiServiceApiRoot, tokenCredentials, ProfileId);
}
```

As you program a multitenant application, you need to switch back and forth between executing calls as the parent service principal and executing calls as a service principal profile. One strategy to manage context switching is to use a class-level **PowerBIClient** property named **pbiClient** and a method named **SetCallingContext** which can be called to switch between caller identities.



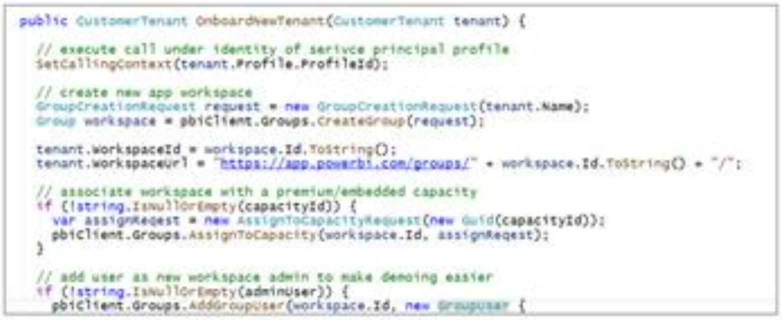
```
private PowerBIClient pbiClient;

private void SetCallingContext(string ProfileId = "") {

  if (ProfileId.Equals("")) {
    pbiClient = GetPowerBiClient();
  }
  else {
    pbiClient = GetPowerBiClientForProfile(new Guid(ProfileId));
  }

}
```

Now, let's say you need to create or manage a service principal profile. You can call **SetCallingContext** without any parameter so calls afterwards will execute under the identity of the service principal.



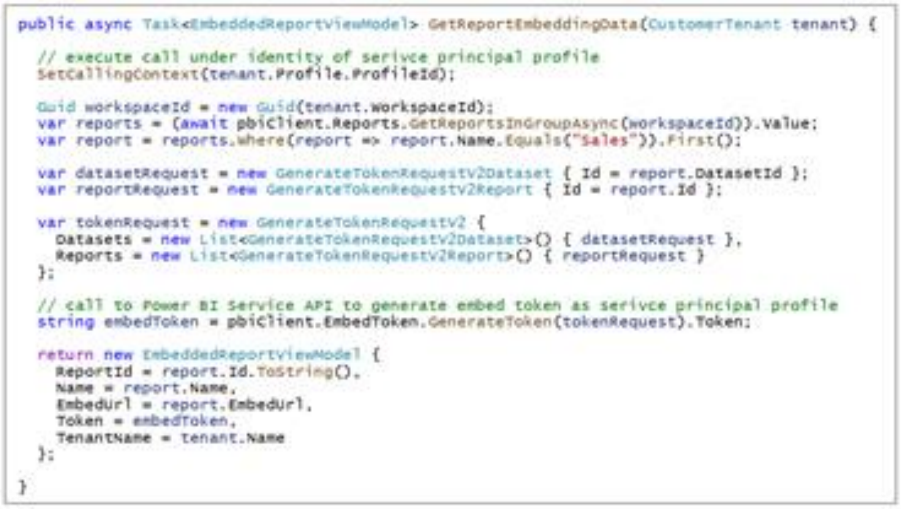
```
public ServicePrincipalProfile CreateProfile(string ProfileName) {

  // always create & manage profiles as service principal
  SetCallingContext();

  var createRequest = new CreateOrUpdateProfileRequest(ProfileName);
  var profile = pbiClient.Profiles.CreateProfile(createRequest);
  return profile;
}
```

When you need to create and configure a new workspace for a new customer tenant, you want to execute that code as a service principal profile. Therefore, you should call **SetCallingContext** and pass the profile id so that Power BI REST operations called afterwards are executed as a service principal profile and not as the parent service principal.



```
public CustomerTenant OnboardNewTenant(CustomerTenant tenant) {

  // execute call under identity of serivce principal profile
  SetCallingContext(tenant.Profile.ProfileId);

  // create new app workspace
  GroupCreationRequest request = new GroupCreationRequest(tenant.Name);
  Group workspace = pbiClient.Groups.CreateGroup(request);

  tenant.WorkspaceId = workspace.Id.ToString();
  tenant.WorkspaceUrl = "https://app.powerbi.com/groups/" + workspace.Id.ToString() + "/";

  // associate workspace with a premium/embedded capacity
  if (!string.IsNullOrEmpty(capacityId)) {
    var assignReqest = new AssignToCapacityRequest(new Guid(capacityId));
    pbiClient.Groups.AssignToCapacity(workspace.Id, assignReqest);
  }

  // add user as new workspace admin to make demoing easier
  if (!string.IsNullOrEmpty(adminUser)) {
    pbiClient.Groups.AddGroupUser(workspace.Id, new GroupUser {
```

Once you have used a specific service principal profile to create and configure a workspace, you should use that same service principal profile later when you need to consume content from that workspace. The following code shows how to execute code as a service principal profile when retrieving embedding metadata and an embed token used to embed a report on a web page.



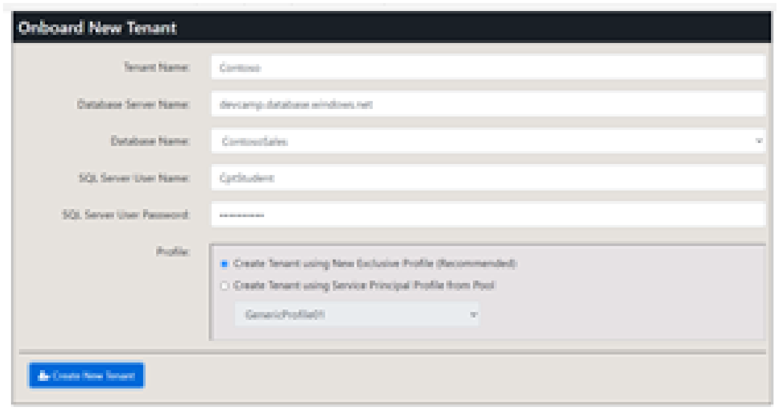
```
public async Task<EmbeddedReportViewModel> GetReportEmbeddingData(CustomerTenant tenant) {

  // execute call under identity of serivce principal profile
  SetCallingContext(tenant.Profile.ProfileId);

  Guid workspaceId = new Guid(tenant.WorkspaceId);
  var reports = (await pbiClient.Reports.GetReportsInGroupAsync(workspaceId)).Value;
  var report = reports.Where(report => report.Name.Equals("Sales")).First();

  var datasetRequest = new GenerateTokenRequestV2Dataset { Id = report.DatasetId };
  var reportRequest = new GenerateTokenRequestV2Report { Id = report.Id };

  var tokenRequest = new GenerateTokenRequestV2 {
    Datasets = new List<GenerateTokenRequestV2Dataset>() { datasetRequest },
    Reports = new List<GenerateTokenRequestV2Report>() { reportRequest }
  };

  // call to Power BI Service API to generate embed token as serivce principal profile
  string embedToken = pbiClient.EmbedToken.GenerateToken(tokenRequest).Token;

  return new EmbeddedReportViewModel {
    ReportId = report.Id.ToString(),
    Name = report.Name,
    EmbedUrl = report.EmbedUrl,
    Token = embedToken,
    TenantName = tenant.Name
  };

}
```

Getting Started with the **AppOwnsDataMultiTenant** application

The **AppOwnsDataMultiTenant** application demonstrates how to manage a multitenant environment for Power BI embedding using service principal profiles. This sample application has been designed to use the best practice of creating a separate service principal profile for each new customer tenant.

The design strategy used by the **AppOwnsDataMultiTenant** application optimizes calls to the Power BI REST API while also providing complete dataset and datasource credential isolation at the customer tenant level. The design of the **AppOwnsDataMultiTenant** application makes it possible to scale upwards to manage an environment with up to and beyond 100,000 customer tenants.

The **AppOwnsDataMultiTenant** application provides a form which allows the user to create a new customer tenant. When using the application, you can enter the **Tenant Name** for a new customer and the details of the customer's database.

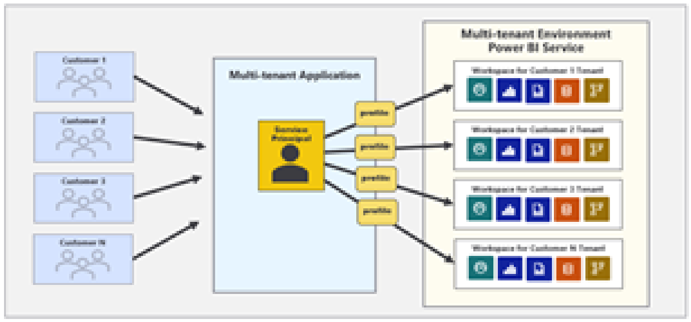


Onboard New Tenant

Tenant Name:	Contoso
Database Server Name:	devcamp.database.windows.net
Database Name:	ContosoSales
SQL Server User Name:	CptStudent
SQL Server User Password:	••••••••••
Profile:	[✓ Create Tenant using New Exclusive Profile (Recommended)] Create Tenant using Service Principal Profile from Pool; GenericProfile01

Create New Tenant

When you click the **Create New Tenant** button, the application responds by executing code which begins by creating a new service principal profile using the same name as the **Tenant Name**. After creating the service principal profile, the application then switches contexts and begins calling the Power BI REST API using that profile's identity to create a new workspace and populate it with content. This application design maintains a one-to-one relationship between service principal profiles and customer tenant workspaces which is what Microsoft recommends as a best practice.



Keep in mind that **AppOwnsDataMultiTenant** is a proof-of-concept (POC) that doesn't include certain behavior that would be required in any real-world application. In particular, this application was not designed to authenticate or authorize the user. You can access all the pages of this application with anonymous access. If you are going to use the **AppOwnsDataMultiTenant** application as a starting point for something you are building, it will be your responsibility to add the code required to authenticate and authorize users who will be responsible for creating and managing customer tenants.

Setting up your development environment

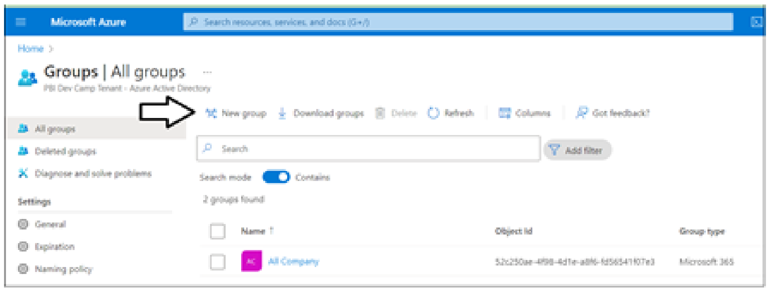
You can follow the steps in this section to set up the **AppOwnsDataMultiTenant** application for testing. To complete these steps, you will require a Microsoft 365 tenant in which you have permissions to create and manage Azure AD applications and security groups. You will also need Power BI Service administrator permissions to configure tenant-level settings for Power BI to enable service principals and service principal profiles with the ability to access the Power BI Service API. If you do not have a Microsoft 365 environment for development and testing, you can create one with free trial licenses by following the steps in Create a Development Environment for Power BI Embedding.

To set up the **AppOwnsDataMultiTenant** application for testing, you will need to configure a Microsoft 365 environment with an Azure AD tenant by completing the following tasks.

- Create an Azure AD security group named **Power BI Apps**
- Configure Power BI tenant-level settings for service principal access
- Configure Power BI tenant-level settings to enable service principal profiles
- Create and configure the Azure AD Application for the **AppOwnsDataMultiTenant** Application

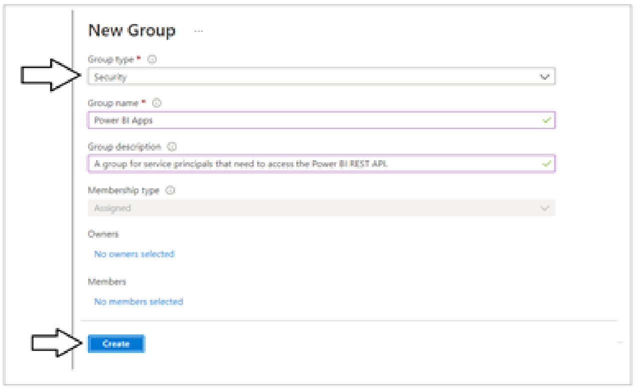
Create an Azure AD security group named Power BI Apps

Begin by navigating to the Groups management page in the Azure portal. Once you get to the **Groups** page in the Azure portal, click the **New group** link.



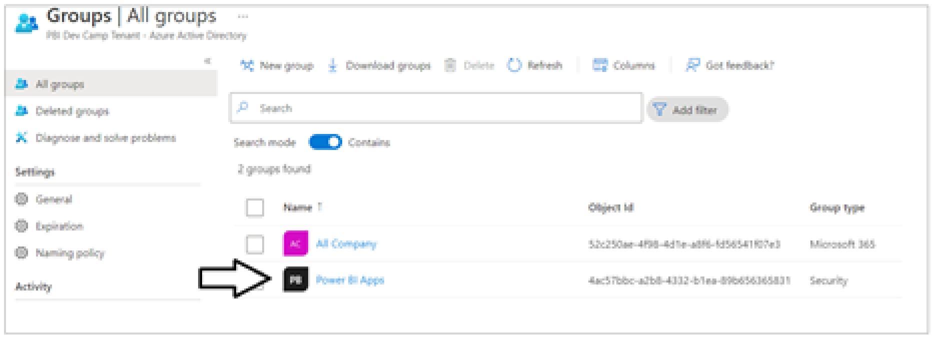
	Name ↑	Object Id	Group type
AC	All Company	52c250ae-4f98-4d1e-a8f6-fd56541f07e3	Microsoft 365

In the **New Group** dialog, Select a **Group type** of **Security** and enter a **Group name** of **Power BI Apps**. Click the **Create** button to create the new Azure AD security group.



Group type *: Security
Group name *: Power BI Apps
Group description: A group for service principals that need to access the Power BI REST API.
Membership type: Assigned

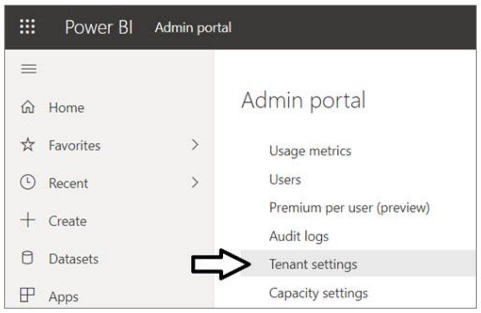
It might take a minute or two before the group appears. Refresh the **All Groups** page a few times until you can verify that you can see the new security group named **Power BI Apps** in the list of groups.



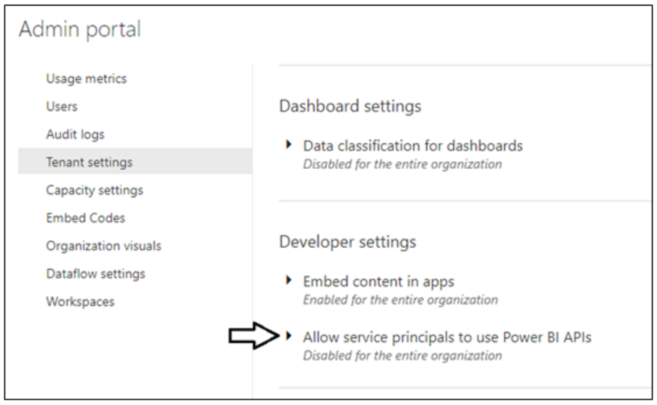
	Name ↑	Object Id	Group type
AC	All Company	52c250ae-4f98-4d1e-a8f6-fd56541f07e3	Microsoft 365
PB	Power BI Apps	4ac57bbc-a2b8-4332-b1ea-89b6563658З1	Security

Configure Power BI tenant-level settings for service principal profile access

Next, you need you enable a tenant-level setting for Power BI named **Allow service principals to use Power BI APIs**. Navigate to the Power BI Service admin portal at https://app.powerbi.com/admin-portal. In the Power BI Admin portal, click the **Tenant settings** link on the left.



Move down in the **Developer settings** section and expand the **Allow service principals to use Power BI APIs** section.


Admin portal

- Usage metrics
- Users
- Audit logs
- Tenant settings
- Capacity settings
- Embed Codes
- Organization visuals
- Dataflow settings
- Workspaces

Dashboard settings

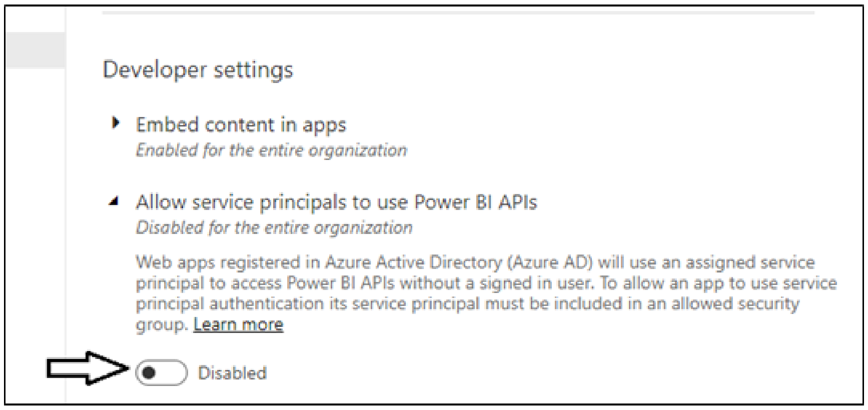
▸ Data classification for dashboards
Disabled for the entire organization

Developer settings

▸ Embed content in apps
Enabled for the entire organization

▸ Allow service principals to use Power BI APIs
Disabled for the entire organization

Note that the **Allow service principals to use Power BI APIs** setting is initially set to **Disabled**.


Developer settings

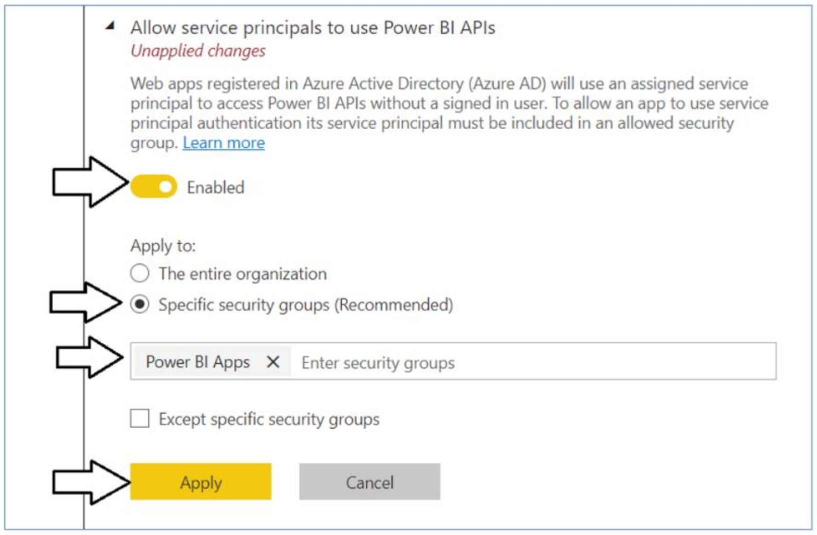
▸ Embed content in apps
Enabled for the entire organization

◂ Allow service principals to use Power BI APIs
Disabled for the entire organization

Web apps registered in Azure Active Directory (Azure AD) will use an assigned service principal to access Power BI APIs without a signed in user. To allow an app to use service principal authentication its service principal must be included in an allowed security group. Learn more

Disabled

Change the setting to **Enabled**. After that, set the **Apply to** setting to **Specific security groups** and add the **Power BI Apps** security group as shown in the screenshot below. Click the **Apply** button to save your configuration changes.


◂ Allow service principals to use Power BI APIs
Unapplied changes

Web apps registered in Azure Active Directory (Azure AD) will use an assigned service principal to access Power BI APIs without a signed in user. To allow an app to use service principal authentication its service principal must be included in an allowed security group. Learn more

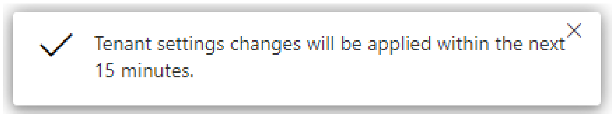
Enabled

Apply to:
- ○ The entire organization
- ● Specific security groups (Recommended)

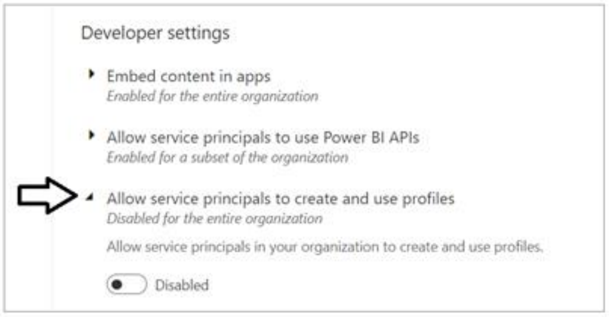
Power BI Apps ✕ Enter security groups

☐ Except specific security groups

You will see a notification indicating it might take up to 15 minutes to apply these changes to the organization.

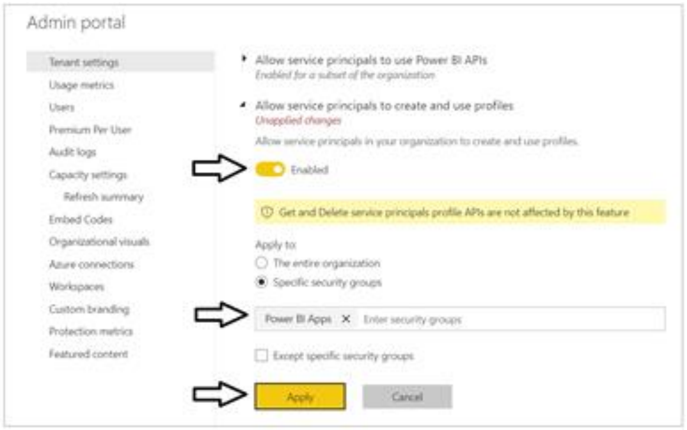

✓ Tenant settings changes will be applied within the next 15 minutes.

Now look down in the **Developer setting** section of the Power BI admin portal and locate and expand the section titled **Allow service principals to create and use profiles**.


Developer settings

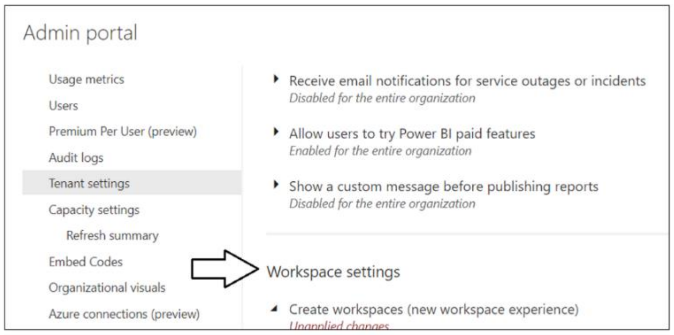
- Embed content in apps
  Enabled for the entire organization
- Allow service principals to use Power BI APIs
  Enabled for a subset of the organization
- Allow service principals to create and use profiles
  Disabled for the entire organization
  Allow service principals in your organization to create and use profiles.
  Disabled

Change the setting to **Enabled**. After that, set the **Apply to** setting to **Specific security groups** and add the **Power BI Apps** security group as shown in the screenshot below. Click the **Apply** button to save your configuration changes.



- Allow service principals to use Power BI APIs
  Enabled for a subset of the organization
- Allow service principals to create and use profiles
  Unapplied changes
  Allow service principals in your organization to create and use profiles.
  Enabled
  Get and Delete service principals profile APIs are not affected by this feature
  Apply to:
  The entire organization
  Specific security groups
  Power BI Apps ✕ Enter security groups
  Except specific security groups
  Apply Cancel

You will see another notification indicating it might take up to 15 minutes to apply these changes to the organization. Now scroll upwards in the **Tenant setting** section of the Power BI admin portal and locate **Workspace settings**.

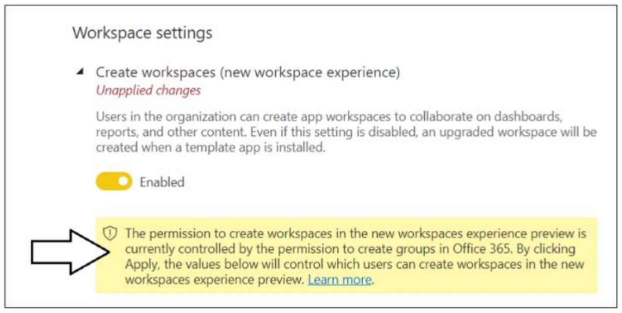


- Receive email notifications for service outages or incidents
  Disabled for the entire organization
- Allow users to try Power BI paid features
  Enabled for the entire organization
- Show a custom message before publishing reports
  Disabled for the entire organization

Workspace settings

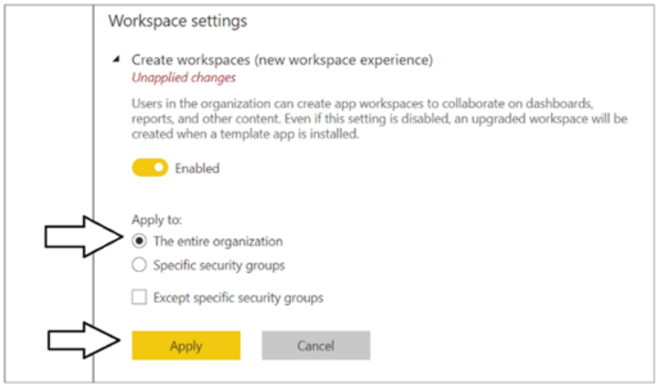
- Create workspaces (new workspace experience)
  Unapplied changes

Note that a Power BI tenant has an older policy by default where users require permissions to create Office 365 groups in order to create new Power BI workspaces. You must reconfigure this setting so that service principal profiles will be able to create new workspaces.


Workspace settings

- Create workspaces (new workspace experience)
  Unapplied changes
  Users in the organization can create app workspaces to collaborate on dashboards, reports, and other content. Even if this setting is disabled, an upgraded workspace will be created when a template app is installed.
  Enabled
  The permission to create workspaces in the new workspaces experience preview is currently controlled by the permission to create groups in Office 365. By clicking Apply, the values below will control which users can create workspaces in the new workspaces experience preview. Learn more.

In **Workspace settings**, set **Apply to : The entire organization** and click the **Apply** button to save your changes.


Workspace settings

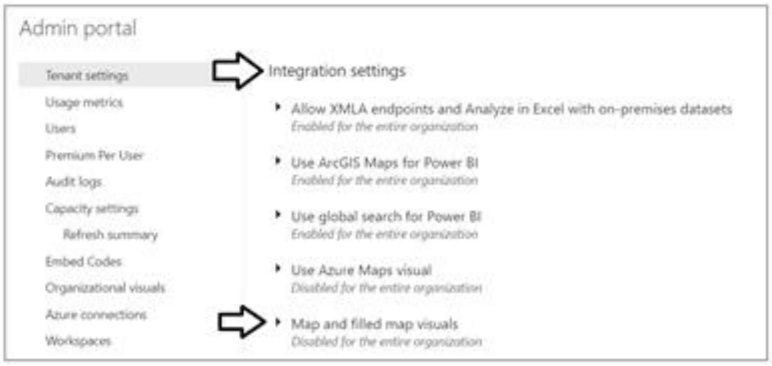
Create workspaces (new workspace experience)
Unapplied changes
Users in the organization can create app workspaces to collaborate on dashboards, reports, and other content. Even if this setting is disabled, an upgraded workspace will be created when a template app is installed.

Enabled

Apply to:
● The entire organization
○ Specific security groups

☐ Except specific security groups

There is one more tenant-level setting that must be enabled for the **AppOwnsDataMultiTenant** application to work correctly. That is the tenant-level setting which makes it possible to use map visuals. Locate the **Integration settings** section in **Tenant settings**. Inside the that section locate and expand the setting named **Map and filled map visuals**.



Integration settings

Allow XMLA endpoints and Analyze in Excel with on-premises datasets
Enabled for the entire organization

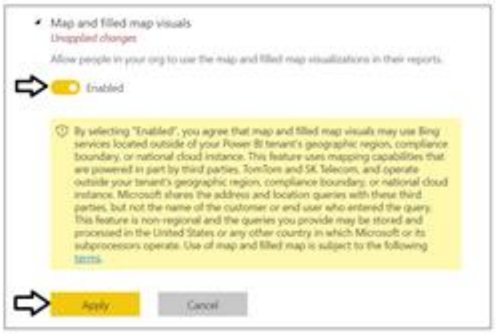
Use ArcGIS Maps for Power BI
Enabled for the entire organization

Use global search for Power BI
Enabled for the entire organization

Use Azure Maps visual
Disabled for the entire organization

Map and filled map visuals
Disabled for the entire organization

Enable the **Map and filled map visuals** setting and then click **Apply**.


Map and filled map visuals
Unapplied changes
Allow people in your org to use the map and filled map visualizations in their reports.

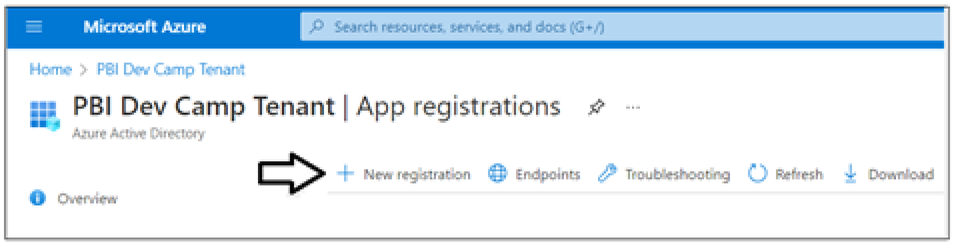
Enabled

By selecting "Enabled", you agree that map and filled map visuals may use Bing services located outside of your Power BI tenant's geographic region, compliance boundary, or national cloud instance. This feature uses mapping capabilities that are powered in part by third parties, TomTom and SK Telecom, and operate outside your tenant's geographic region, compliance boundary, or national cloud instance. Microsoft shares the address and location queries with these third parties, but not the name of the customer or end user who entered the query. This feature is non-regional and the queries you provide may be stored and processed in the United States or any other country in which Microsoft or its subprocessors operate. Use of map and filled map is subject to the following terms.

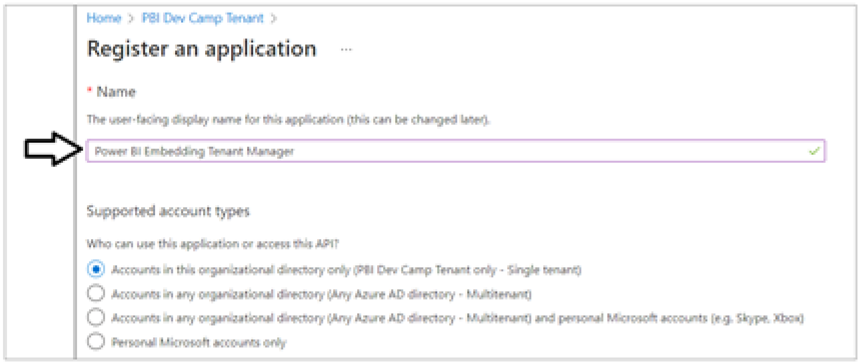
You have now completed the configuration of Power BI tenant-level settings. Now you can move ahead to create the Azure AD application that will be used by the **AppOwnsDataMultiTenant** application.

Create the Azure AD Application for the AppOwnsDataMultiTenant Application

Login to the Azure portal to create the new Azure AD application. Begin by navigating to the App registration page in the Azure portal and click the **New registration** link.


Microsoft Azure
Search resources, services, and docs (G+/)
Home > PBI Dev Camp Tenant
PBI Dev Camp Tenant | App registrations
Azure Active Directory
New registration
Endpoints
Troubleshooting
Refresh
Download
Overview

On the **Register an application** page, enter an application name such as **Power BI Embedding Tenant Manager** and accept the default selection for **Supported account types** of **Accounts in this organizational directory only**.



Home > PBI Dev Camp Tenant >

Register an application ...

* Name

The user-facing display name for this application (this can be changed later).

Power BI Embedding Tenant Manager

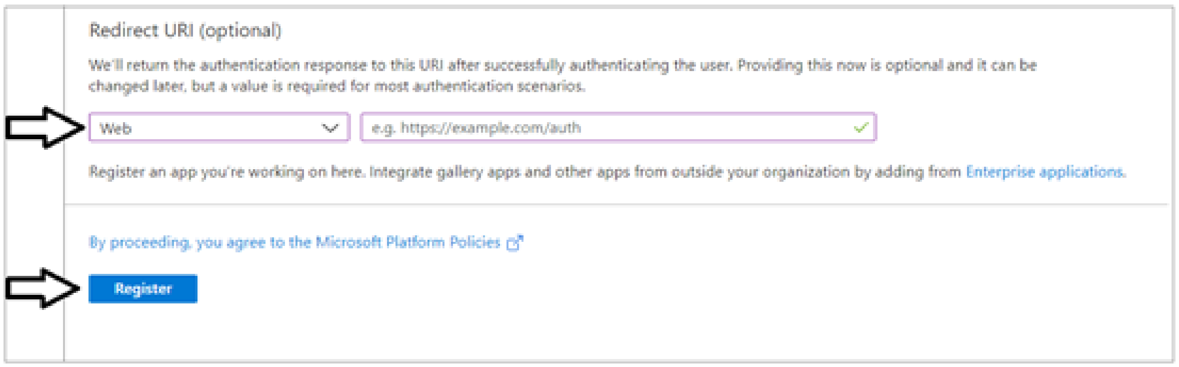
Supported account types

Who can use this application or access this API?

- [✓ Accounts in this organizational directory only (PBI Dev Camp Tenant only - Single tenant)]
- Accounts in any organizational directory (Any Azure AD directory - Multitenant)
- Accounts in any organizational directory (Any Azure AD directory - Multitenant) and personal Microsoft accounts (e.g. Skype, Xbox)
- Personal Microsoft accounts only

Complete the following steps in the **Redirect URI** section.

- Set the dropdown selection to **Web** in the dropdown box
- Do not enter a value for the **Redirect URI**. Leave it blank.
- Click the **Register** button to create the new Azure AD application.



Redirect URI (optional)

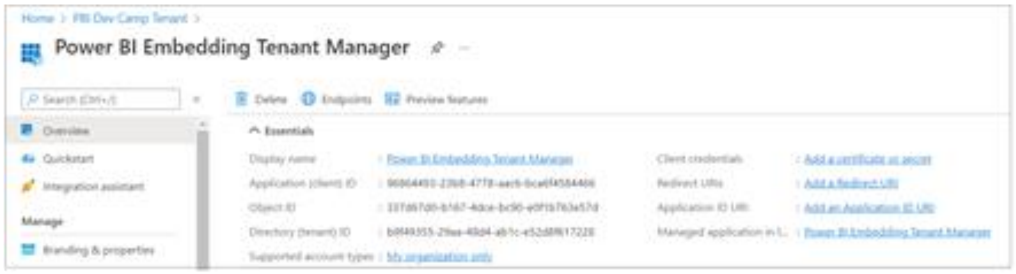
We'll return the authentication response to this URI after successfully authenticating the user. Providing this now is optional and it can be changed later, but a value is required for most authentication scenarios.

Web | e.g. https://example.com/auth

Register an app you're working on here. Integrate gallery apps and other apps from outside your organization by adding from Enterprise applications.

By proceeding, you agree to the Microsoft Platform Policies

After creating a new Azure AD application in the Azure portal, you should see the Azure AD application overview page which displays the **Application ID**. Note that the ***Application ID*** is often called the ***Client ID***, so don't let this confuse you. You will need to copy this Application ID and store it so you can use it later to configure the project's support for Client Credentials Flow.



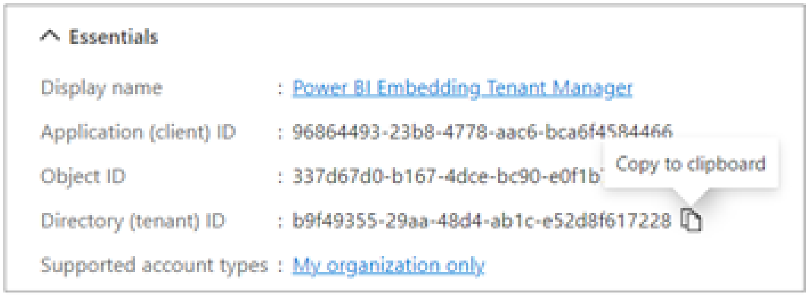
Home > PBI Dev Camp Tenant >

Power BI Embedding Tenant Manager

Essentials

Display name	: Power BI Embedding Tenant Manager	Client credentials	: Add a certificate or secret
Application (client) ID	: 96864493-23b8-4778-aac6-bca6f4584466	Redirect URIs	: Add a Redirect URI
Object ID	: 337d67d0-b167-4dce-bc90-e0f1b763a57d	Application ID URI	: Add an Application ID URI
Directory (tenant) ID	: b9f49355-29aa-48d4-ab1c-e52d8f617228	Managed application in l...	: Power BI Embedding Tenant Manager
Supported account types	: My organization only		

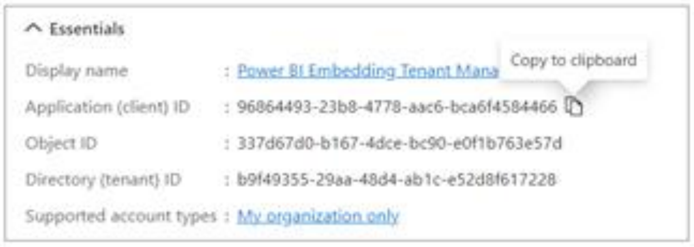
Copy the **Tenant ID** (aka Directory ID) and paste it into a text document so you can use it later in the setup process. Note that this **Tenant ID** value will be used by **AppOwnsDataMultiTenant** project to configure authentication with Azure AD.



Essentials

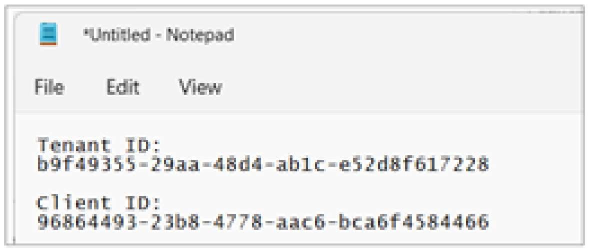
Display name	: Power BI Embedding Tenant Manager
Application (client) ID	: 96864493-23b8-4778-aac6-bca6f4584466
Object ID	: 337d67d0-b167-4dce-bc90-e0f1b
Directory (tenant) ID	: b9f49355-29aa-48d4-ab1c-e52d8f617228
Supported account types	: My organization only

Next, repeat the same step by copying the **Client ID** and copying that into the text document as well.



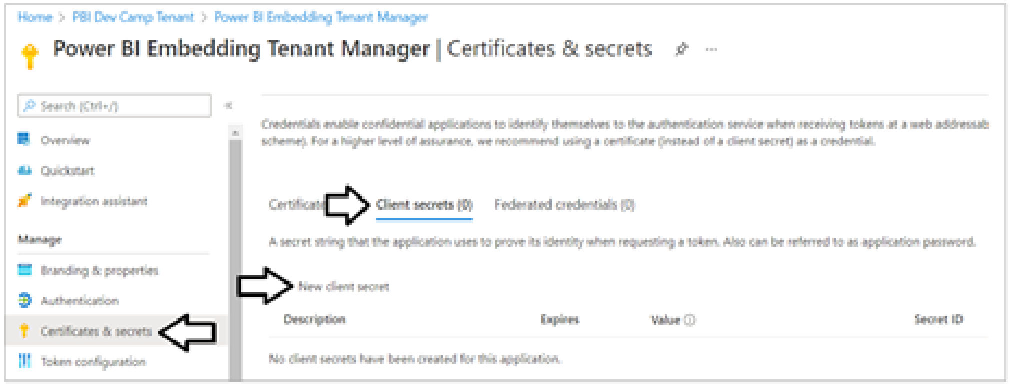
Display name	: Power BI Embedding Tenant Mana
Application (client) ID	: 96864493-23b8-4778-aac6-bca6f4584466
Object ID	: 337d67d0-b167-4dce-bc90-e0f1b763e57d
Directory (tenant) ID	: b9f49355-29aa-48d4-ab1c-e52d8f617228
Supported account types	: My organization only

Your text document should now contain the **Tenant ID** and **Client ID** as shown in the following screenshot.



```
Tenant ID:
b9f49355-29aa-48d4-ab1c-e52d8f617228

Client ID:
96864493-23b8-4778-aac6-bca6f4584466
```

Next, you need to create a Client Secret for the application. Click on the **Certificates & secrets** link in the left navigation to move to the **Certificates & secrets** page. On the **Client secrets** tab, click the **New client secret** button as shown in the following screenshot.

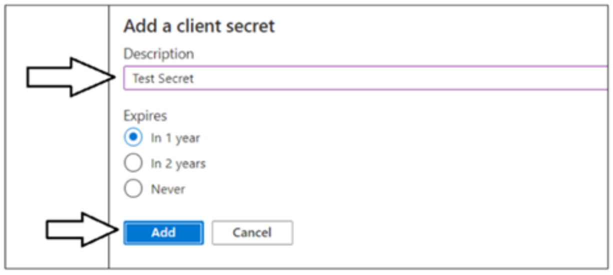


Credentials enable confidential applications to identify themselves to the authentication service when receiving tokens at a web addressab scheme). For a higher level of assurance, we recommend using a certificate (instead of a client secret) as a credential.

A secret string that the application uses to prove its identity when requesting a token. Also can be referred to as application password.

Description	Expires	Value	Secret ID
No client secrets have been created for this application.			

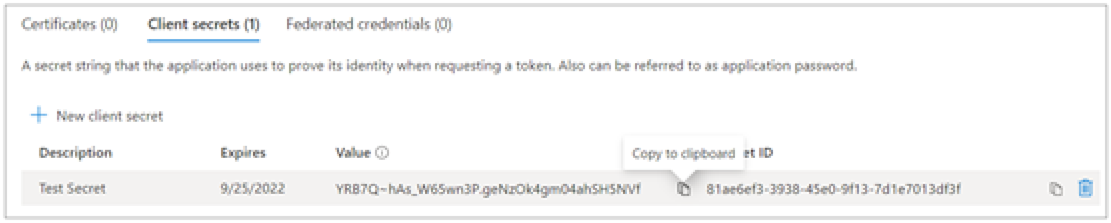
In the **Add a client secret** dialog, add a text description such as **Test Secret** and then click the **Add** button to create the new Client Secret.



Description: Test Secret

Expires: [✓ In 1 year] In 2 years Never

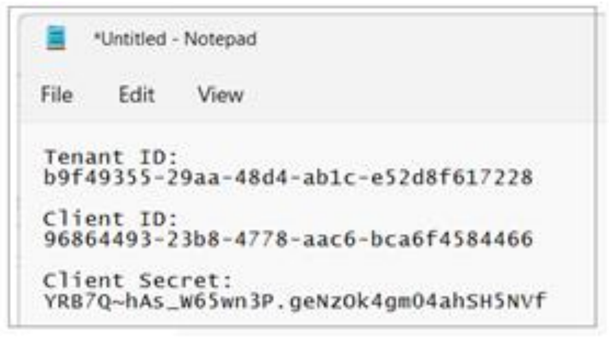
Once you have created the Client Secret, you should be able to see its **Value** in the **Client secrets** section. Click on the **Copy to clipboard** button to copy the **Value** for the **Client Secret** into the clipboard.



A secret string that the application uses to prove its identity when requesting a token. Also can be referred to as application password.

Description	Expires	Value	et ID
Test Secret	9/25/2022	YRB7Q~hAs_W6Swn3P.geNzOk4gm04ahSHSNVf	81ae6ef3-3938-45e0-9f13-7d1e7013df3f

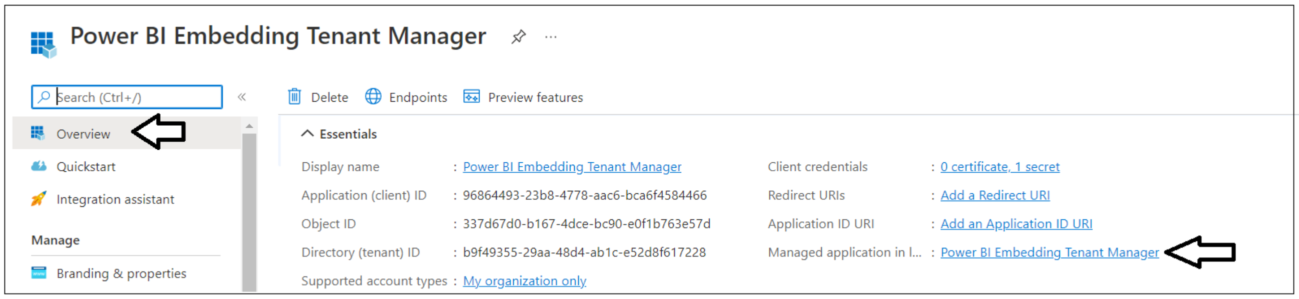
Paste the **Client Secret** into the same text document with the **Client ID** and **Tenant ID**.



```
Tenant ID:
b9f49355-29aa-48d4-ab1c-e52d8f617228

Client ID:
96864493-23b8-4778-aac6-bca6f4584466

Client Secret:
YRB7Q~hAs_W65wn3P.geNzOk4gm04ahSH5NVf
```

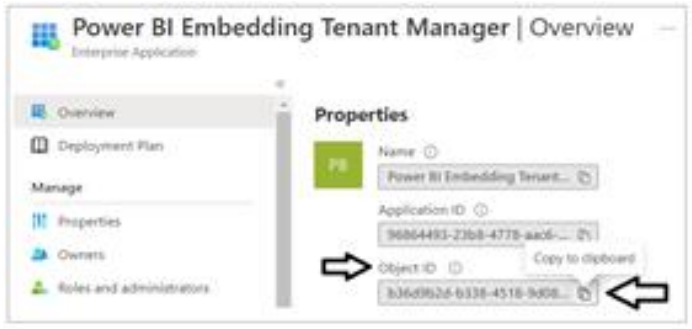
At this point, you have the Tenant Id, Client Id and Client Secret. This is all you need to authenticate with Azure AD to acquire an access token for the service principal. However, you need to capture one more GUID for the service principal object Id. You will need this Id value in any scenario where you need to add the service principal of one of its profiles as a member in a Power BI workspace.

Navigate back to the Overview page for the new Azure AD application. Click the **Managed application in local directory** link as shown in the following screenshot to navigate to the application's **Properties** page.



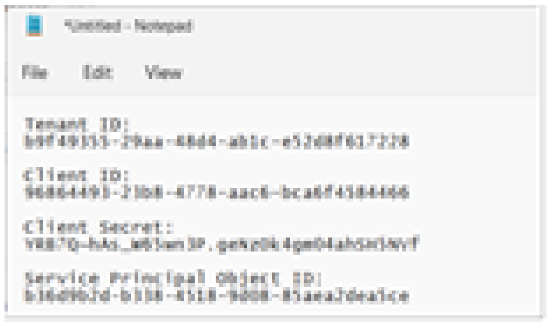
Display name	: Power BI Embedding Tenant Manager	Client credentials	: 0 certificate, 1 secret
Application (client) ID	: 96864493-23b8-4778-aac6-bca6f4584466	Redirect URIs	: Add a Redirect URI
Object ID	: 337d67d0-b167-4dce-bc90-e0f1b763e57d	Application ID URI	: Add an Application ID URI
Directory (tenant) ID	: b9f49355-29aa-48d4-ab1c-e52d8f617228	Managed application in l...	: Power BI Embedding Tenant Manager
Supported account types	: My organization only		

On the **Properties** page, locate the **Object ID** value and copy it to the clipboard. This value represents the service principal object Id.



Name: Power BI Embedding Tenant...
Application ID: 96864493-23b8-4778-aac6-...
Object ID: b36d9b2d-b338-4518-9d08...

Now paste the service principal into the text document with the other values as shown in the following screenshot.

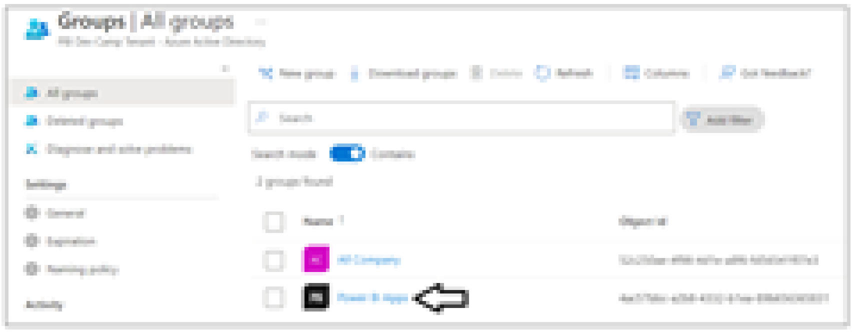


```
Tenant ID:
b9f49355-29aa-48d4-ab1c-e52d8f617228

Client ID:
96864493-23b8-4778-aac6-bca6f4584466

Client Secret:
YRB7Q~hAs_W65wn3P.geNzOk4gm04ahSH5NVf

Service Principal Object ID:
b36d9b2d-b338-4518-9d08-85aea2dea1ce
```

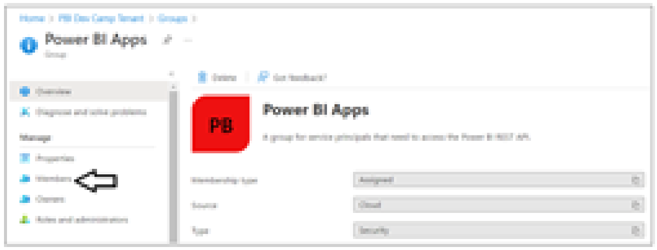
Save the text file so you don’t accidently close it and lose the configuration data inside. You will copy and paste these Id values into the **AppOwnsDataMultiTenant** project later when you set up the application for testing.

Add the Azure AD Application to the Power BI Apps Group

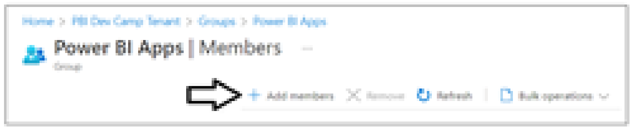
In this step you will finalize the configuration in Azure AD by adding the **Power BI Embedding Tenant Manager** application to the **Power BI Apps** security group. Navigate back to the Groups management page and locate the security group created earlier named **Power BI Apps**. Click on the **Power BI Apps** link to drill into the summary page for this security group.



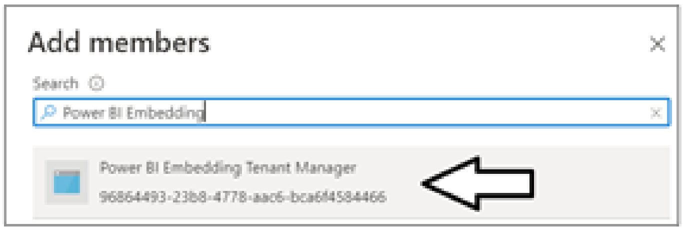
On the **Power BI Apps** security group summary page, click the **Members** link to navigate to the **Members** page.



On the **Members** page, click the **Add members** link to display the **Add members** pane.



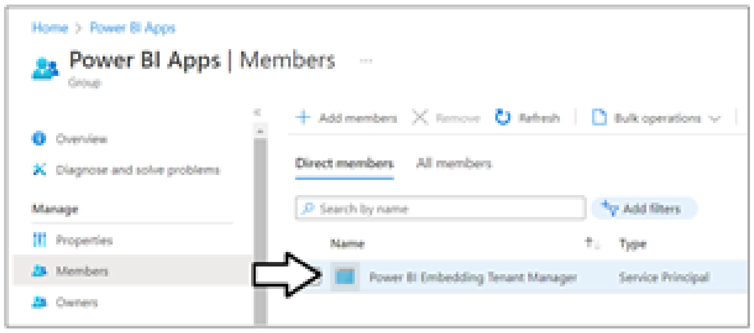
In the **Add members** pane, locate and select the **Power BI Embedding Tenant Manager** application. Add this application to the **Power BI Apps** security group.



Power BI Embedding

Power BI Embedding Tenant Manager
96864493-23b8-4778-aac6-bca6f4584466

Verify that the **Power BI Embedding Tenant Manager** application is now a member of the **Power BI Apps** group.



Name	Type
Power BI Embedding Tenant Manager	Service Principal

You are now finished in configuring Azure AD for the application setup.

Set Up the AppOwnsDataMultiTenant Application in Visual Studio 2022

In order to run and test the **AppOwnsDataMultiTenant** project on a developer workstation, you must install the .NET 6 SDK and/or Visual Studio 2022. If you use Visual Studio 2022, you can use any edition including the free Community edition. While this document will walk through the steps of opening and running the this project using Visual Studio 2022, you can also open and run the project using Visual Studio Code if you prefer that IDE.

Here are links to download this software if you need them.

- .NET 6 SDK – [**download**]
- Visual Studio 2022 – [**download**]
- Visual Studio Code – [**download**]

Download the Source Code

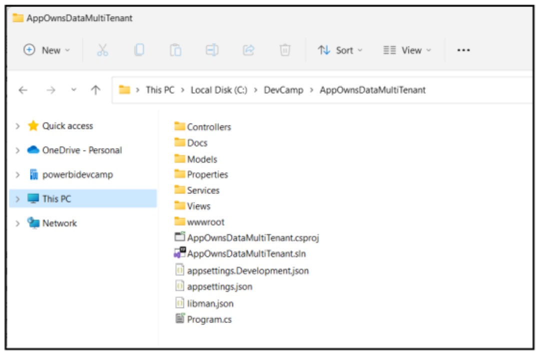
The source code for **AppOwnsDataMultiTenant** is maintained in a GitHub repository at the following URL.

```
https://github.com/PowerBiDevCamp/AppOwnsDataMultiTenant
```

You can download the **AppOwnsDataMultiTenant** project source files in a single ZIP archive using this link. If you are familiar with the **git** utility, you can clone the project source files to your local developer workstation using the following **git** command.

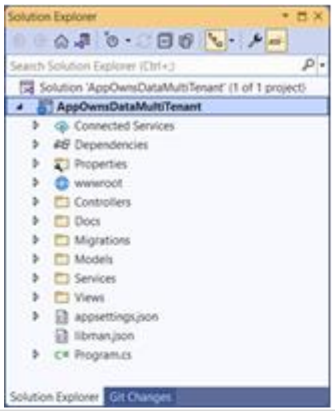
```
git clone https://github.com/PowerBiDevCamp/AppOwnsDataMultiTenant.git
```

Once you have downloaded the source files for the **AppOwnsDataMultiTenant** repository to your developer workstation, you will see there is a top-level project folder named **AppOwnsDataMultiTenant** which contains several files including a solution file named **AppOwnsDataMultiTenant.sln** and a project file named **AppOwnsDataMultiTenant.csproj**.

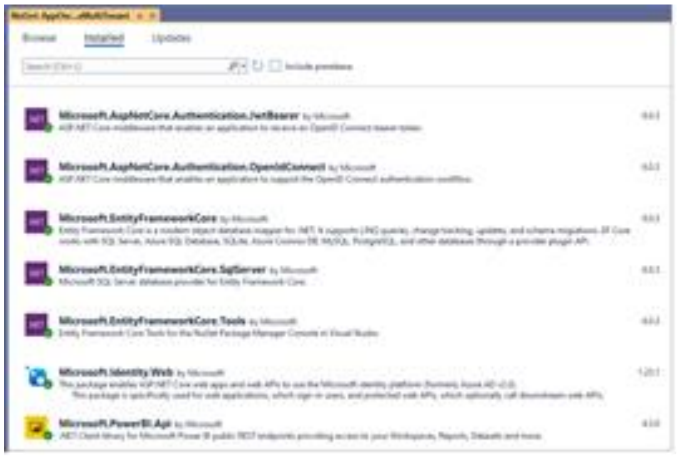


Open the Project in Visual Studio 2022

Launch Visual Studio 2022 and use the **File > Open > Project/Solution** menu command to open the solution file named **AppOwnsDataMultiTenant.sln**. You should note that this development project has been built as a .NET 6 MVC Web Application as shown in the following screenshot.

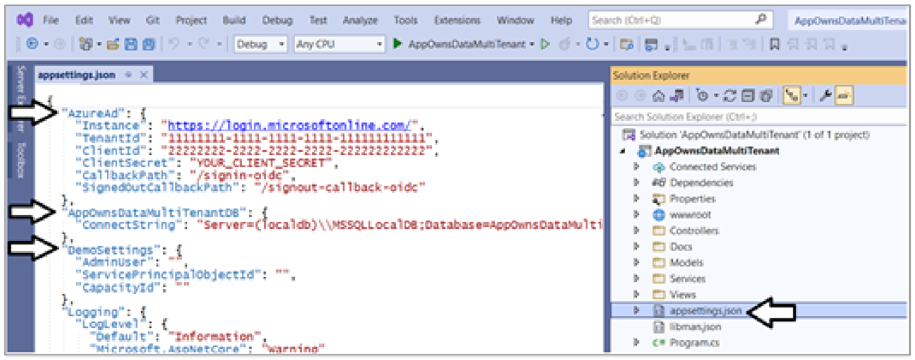


Let's quickly review the NuGet packages that have been installed in the **AppOwnsDataMultiTenant** project. There are several NuGet packages which add Entity Framework support which makes it possible to quickly create the SQL Server database associated with this project. There is a package included to add Azure AD authentication support named **Microsoft.Identity.Web**. The package named **Microsoft.PowerBI.Api** is the Power BI .NET SDK which has been included to support .NET programming with the Power BI REST API.


Microsoft.AspNetCore.Authentication.JwtBearer
Microsoft.AspNetCore.Authentication.OpenIdConnect
Microsoft.EntityFrameworkCore
Microsoft.EntityFrameworkCore.SqlServer
Microsoft.EntityFrameworkCore.Tools
Microsoft.Identity.Web
Microsoft.PowerBI.Api

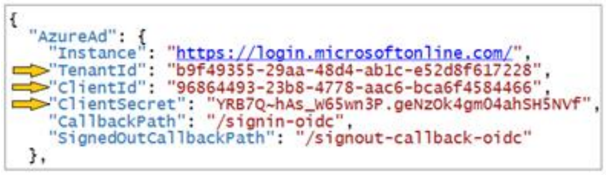
Update application settings in the appsettings.json file

Before you can run the application in the Visual Studio debugger, you must update several critical application settings in the **appsettings.json** file. Open the **appsettings.json** file and examine the JSON content inside. There are three important sections named **AzureAd**, **AppOwnsDataMultiTenantDB** and **DemoSettings**.



```
{
  "AzureAd": {
    "Instance": "https://login.microsoftonline.com/",
    "TenantId": "11111111-1111-1111-1111-111111111111",
    "ClientId": "22222222-2222-2222-2222-222222222222",
    "ClientSecret": "YOUR_CLIENT_SECRET",
    "CallbackPath": "/signin-oidc",
    "SignedOutCallbackPath": "/signout-callback-oidc"
  },
  "AppOwnsDataMultiTenantDB": {
    "ConnectString": "Server=(localdb)\\MSSQLLocalDB;Database=AppOwnsDataMulti
  },
  "DemoSettings": {
    "AdminUser": "",
    "ServicePrincipalObjectId": "",
    "CapacityId": ""
  },
  "Logging": {
    "LogLevel": {
      "Default": "Information",
      "Microsoft.AspNetCore": "Warning"
```

Inside the **AzureAd** section, update the **TenantId**, **ClientId** and **ClientSecret** with the data you collected when creating the Azure AD application named **Power BI Tenant Management Application.**



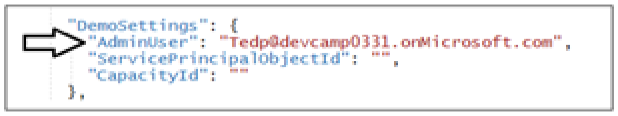
```
{
  "AzureAd": {
    "Instance": "https://login.microsoftonline.com/",
    "TenantId": "b9f49355-29aa-48d4-ab1c-e52d8f617228",
    "ClientId": "96864493-23b8-4778-aac6-bca6f4584466",
    "ClientSecret": "YRB7Q~hAs_W65wn3P.geNzOk4gmO4ahSH5NVf",
    "CallbackPath": "/signin-oidc",
    "SignedOutCallbackPath": "/signout-callback-oidc"
  },
```

Now let's examine the **AppOwnsDataMultiTenantDB** section and the setting inside named **ConnectString**. This is the connection string that will be used by the Entity Framework to create the SQL Server database that will be used by the **AppOwnsDataMultiTenant** application. If you are using Visual Studio 2022, you should be able leave the database connection string the way it is with the **Server** setting of **(localdb)\\MSSQLLocalDB**. If you'd rather create the **AppOwnsDataMultiTenantDB** database in a different location, you can update the value of this connection string to point to a different server.

```
"AppOwnsDataMultiTenantDB": {
  "ConnectString": "Server=(localdb)\\MSSQLLocalDB;Database=AppOwnsDataMultiTenantDB;Integrated Security=True"
},
```

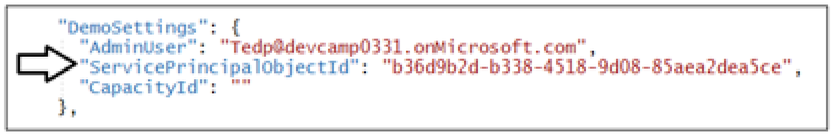
In the **DemoSettings** section there is a property named **AdminUser**. The reason that this property exists has to with you being able to view and examine Power BI workspaces as they are created by service principal profiles. There is code in the **AppOwnsDataMultiTenant** application that will add the user specified by the **AdminUser** setting as a workspace admin any times it creates a new Power BI workspace. This just makes things much easier for you to see what's going on when you begin to run and test the application.

Update the **AdminUser** setting with your Azure AD account name so that you will be able to see all the Power BI workspaces created by this application.



```
"DemoSettings": {
  "AdminUser": "Tedp@devcamp0331.onmicrosoft.com",
  "ServicePrincipalObjectId": "",
  "CapacityId": ""
},
```

In the **DemoSettings** section there is a property named **ServicePrincipalObjectId**. The reason this property exists has to do with adding the service principal or a service principal profile as a workspace member. Update the **ServicePrincipalObjectId** setting with the value you Service Principal Object Id value you collected earlier.



```
"DemoSettings": {
  "AdminUser": "Tedp@devcamp0331.onmicrosoft.com",
  "ServicePrincipalObjectId": "b36d9b2d-b338-4518-9d08-85aea2dea5ce",
  "CapacityId": ""
},
```

In the **DemoSettings** section there is a property named **CapacityId**. The reason this property exists has to do with automating the step of associating new workspaces with a premium capacity. If you have the GUID-based ID for a premium capacity, you can update this setting and the application will automatically associate new workspaces with this capacity each time it creates a new workspace. If you don't have a Capacity ID, that is not a problem. Simply leave the **CapacityId** setting as an empty string and the application will ignore this setting.

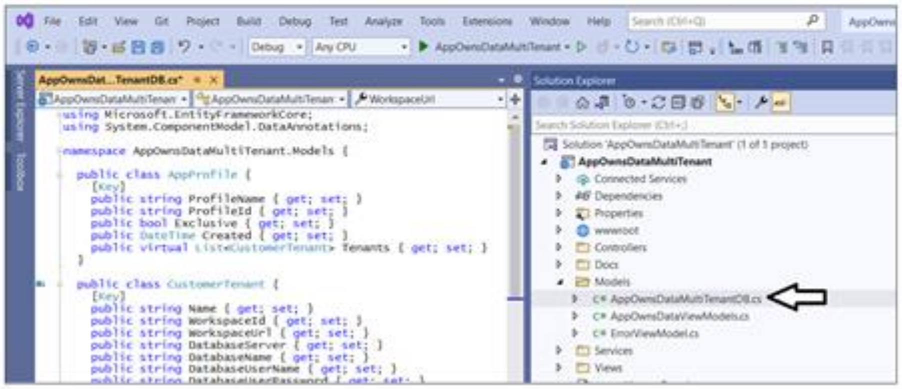
Once you have made your changes. save and close the **appsettings.json** file. You are now ready to move on to the step where you will create the new database named **AppOwnsDataMultiTenantDB**.

Create the AppOwnsDataMultiTenantDB database

When developing with service principal profiles, it's a common practice to use a custom database to track service principal profiles and customer tenants. The **AppOwnsDataMultiTenant** application has been designed with a SQL Server database named **AppOwnsDataMultiTenantDB** which will provide two tables named **Profiles** and **Tenants** to track service principal profiles and customer tenants as they are created by the application.

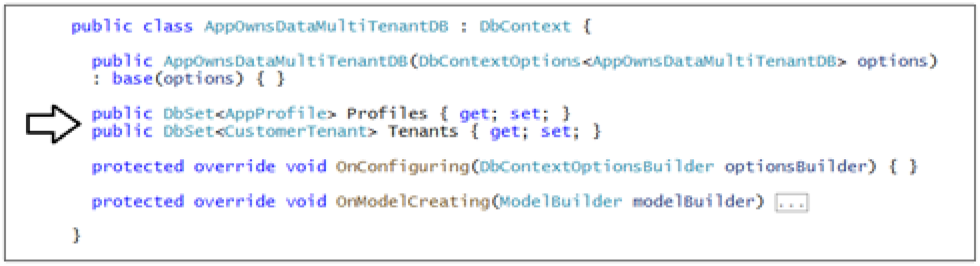
Before you can run the application in Visual Studio, you must create the **AppOwnsDataMultiTenantDB** database. This database schema has been created using the .NET 6 version of the Entity Framework. In this step, you will execute two PowerShell cmdlets provided by Entity Framework to create the database.

Before creating the **AppOwnsDataMultiTenantDB** database, take a moment to understand how it's been structured. Start by opening the file named **AppOwnsDataMultiTenantDB.cs** in the **Models** folder. Note that you shouldn't make any changes to **AppOwnsDataMultiTenantDB.cs**. You are just going to inspect the file to understand how the **AppOwnsDataMultiTenantDB** database is structured.



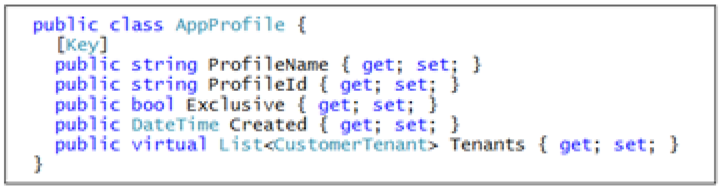
```
using Microsoft.EntityFrameworkCore;
using System.ComponentModel.DataAnnotations;

namespace AppOwnsDataMultiTenant.Models {

  public class AppProfile {
    [Key]
    public string ProfileName { get; set; }
    public string ProfileId { get; set; }
    public bool Exclusive { get; set; }
    public DateTime Created { get; set; }
    public virtual List<CustomerTenant> Tenants { get; set; }
  }

  public class CustomerTenant {
    [Key]
    public string Name { get; set; }
    public string WorkspaceId { get; set; }
    public string WorkspaceUrl { get; set; }
    public string DatabaseServer { get; set; }
    public string DatabaseName { get; set; }
    public string DatabaseUserName { get; set; }
    public string DatabaseUserPassword { get; set; }
```

When you inspect the code inside **AppOwnsDataMultiTenantDB.cs**, you will see a class named **AppOwnsDataMultiTenantDB** that derives from **DbContext**. This class adds support for automatic database generation using Entity Framework. The **AppOwnsDataMultiTenantDB** class serves as the top-level class for the Entity Framework which contains two **DBSet** properties named **Profiles** and **Tenants**.



```
public class AppOwnsDataMultiTenantDB : DbContext {

  public AppOwnsDataMultiTenantDB(DbContextOptions<AppOwnsDataMultiTenantDB> options)
  : base(options) { }

  public DbSet<AppProfile> Profiles { get; set; }
  public DbSet<CustomerTenant> Tenants { get; set; }

  protected override void OnConfiguring(DbContextOptionsBuilder optionsBuilder) { }

  protected override void OnModelCreating(ModelBuilder modelBuilder) ...

}
```

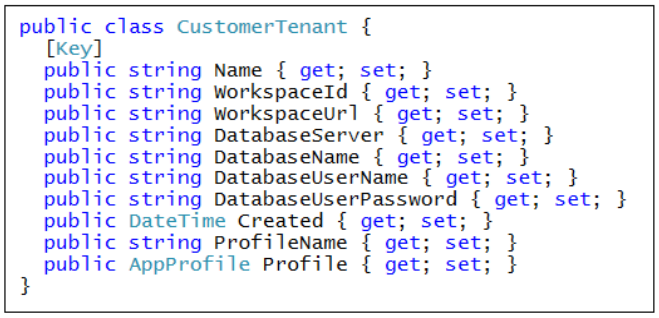
When you generate the database, each of these **DBSet** properties will be created as database tables. The **Profiles** table is generated using the table schema defined by the **AppProfile** class.



```
public class AppProfile {
  [Key]
  public string ProfileName { get; set; }
  public string ProfileId { get; set; }
  public bool Exclusive { get; set; }
  public DateTime Created { get; set; }
  public virtual List<CustomerTenant> Tenants { get; set; }
}
```

As you saw earlier, Power BI tracks an **id** and **displayName** property for each profile. The **AppProfile** class defines **ProfileName** and **ProfileId** to track these properties. However, the **AppProfile** class defines two extra properties named **Exclusive** and **Created** so that application can track addition metadata about each service principal profile it creates.

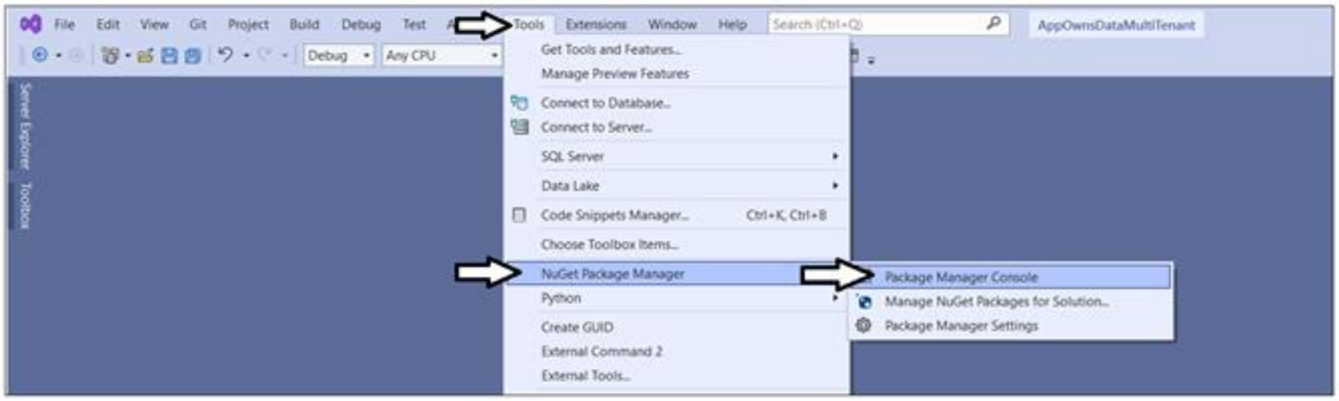
The **Tenants** table is generated using the table schema defined by the **CustomerTenant** class.



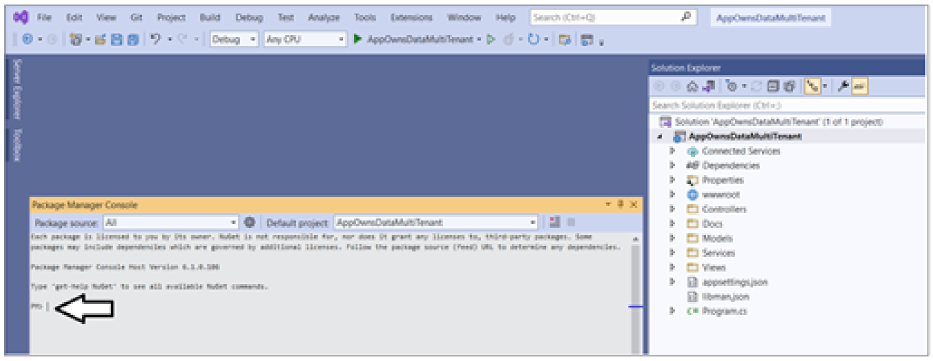
```
public class CustomerTenant {
  [Key]
  public string Name { get; set; }
  public string WorkspaceId { get; set; }
  public string WorkspaceUrl { get; set; }
  public string DatabaseServer { get; set; }
  public string DatabaseName { get; set; }
  public string DatabaseUserName { get; set; }
  public string DatabaseUserPassword { get; set; }
  public DateTime Created { get; set; }
  public string ProfileName { get; set; }
  public AppProfile Profile { get; set; }
}
```

After you have inspected the code used to generated the database, close the source file named **AppOwnsDataMultiTenantDB.cs** without saving any changes. The next step is to run the PowerShell commands to create the project database named **AppOwnsDataMultiTenantDB**.

Open the Package Manager console using **Tools > NuGet Package Manager > Package Manager Console**.



You should see the **Package Manager Console** command prompt where you can execute PowerShell commands.

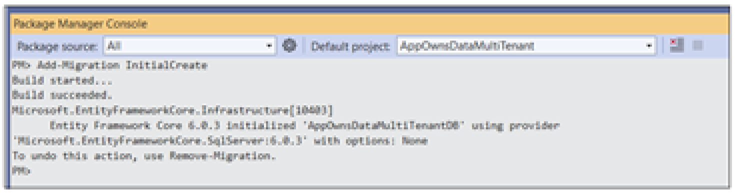


```
Each package is licensed to you by its owner. NuGet is not responsible for, nor does it grant any licenses to, third-party packages. Some
packages may include dependencies which are governed by additional licenses. Follow the package source (feed) URL to determine any dependencies.

Package Manager Console Host Version 6.1.0.106

Type 'get-help NuGet' to see all available NuGet commands.

PM> |
```

Type and execute the following **Add-Migration** command to create a new Entity Framework migration in the project.

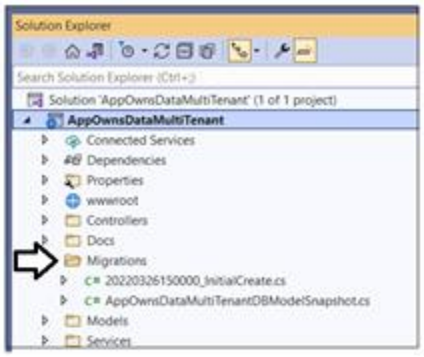
```
Add-Migration InitialCreate
```

The **Add-Migration** command should run without errors. If this command fails you might have to modify the database connection string in **appsettings.json**.



```
PM> Add-Migration InitialCreate
Build started...
Build succeeded.
Microsoft.EntityFrameworkCore.Infrastructure[10403]
      Entity Framework Core 6.0.3 initialized 'AppOwnsDataMultiTenantDB' using provider
'Microsoft.EntityFrameworkCore.SqlServer:6.0.3' with options: None
To undo this action, use Remove-Migration.
PM>
```

After running the **Add-Migration** command, you will see a new folder has been added to the project named **Migrations** with several C# source files. There is no need to change anything in these source files but you can inspect what's inside them if you are curious how the Entity Framework does its work.

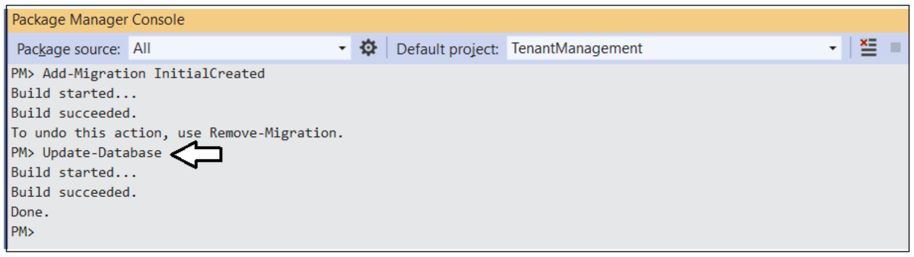


Solution Explorer
Search Solution Explorer (Ctrl+;)
Solution 'AppOwnsDataMultiTenant' (1 of 1 project)
AppOwnsDataMultiTenant
Connected Services
Dependencies
Properties
wwwroot
Controllers
Docs
Migrations
20220326150000_InitialCreate.cs
AppOwnsDataMultiTenantDBModelSnapshot.cs
Models
Services

Return to the **Package Manager Console** and run the following **Update-Database** command to generate the database named **AppOwnsDataMultiTenantDB**.

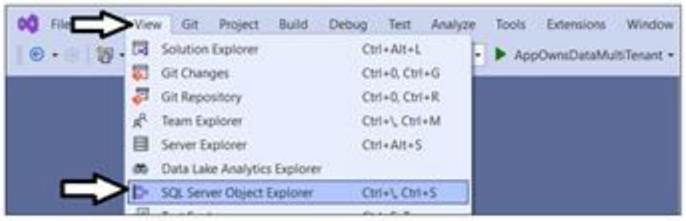
```
Update-Database
```

The **Update-Database** command should run and generate the database named **AppOwnsDataMultiTenantDB**.

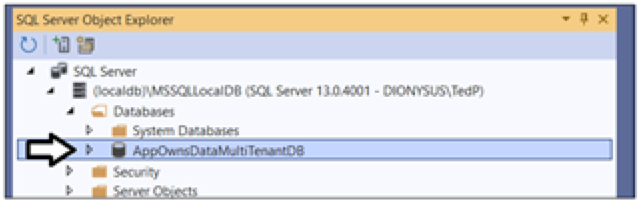


```
PM> Add-Migration InitialCreated
Build started...
Build succeeded.
To undo this action, use Remove-Migration.
PM> Update-Database
Build started...
Build succeeded.
Done.
PM>
```

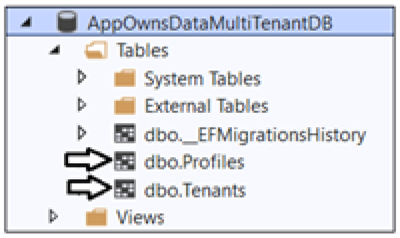
In Visual Studio, you can use the **SQL Server Object Explorer** to see the database that has just been created. Open the **SQL Server Object Explorer** by invoking the **View > SQL Server Object Explorer** menu command.


File
View
Git
Project
Build
Debug
Test
Analyze
Tools
Extensions
Window
Solution Explorer Ctrl+Alt+L
Git Changes Ctrl+0, Ctrl+G
Git Repository Ctrl+0, Ctrl+R
Team Explorer Ctrl+\, Ctrl+M
Server Explorer Ctrl+Alt+S
Data Lake Analytics Explorer
SQL Server Object Explorer Ctrl+\, Ctrl+S
AppOwnsDataMultiTenant

Expand the **Databases** node for the server you are using and verify you an see the new database named **AppOwnsDataMultiTenantDB**.


SQL Server Object Explorer
SQL Server
(localdb)\MSSQLLocalDB (SQL Server 13.0.4001 - DIONYSUS\TedP)
Databases
System Databases
AppOwnsDataMultiTenantDB
Security
Server Objects

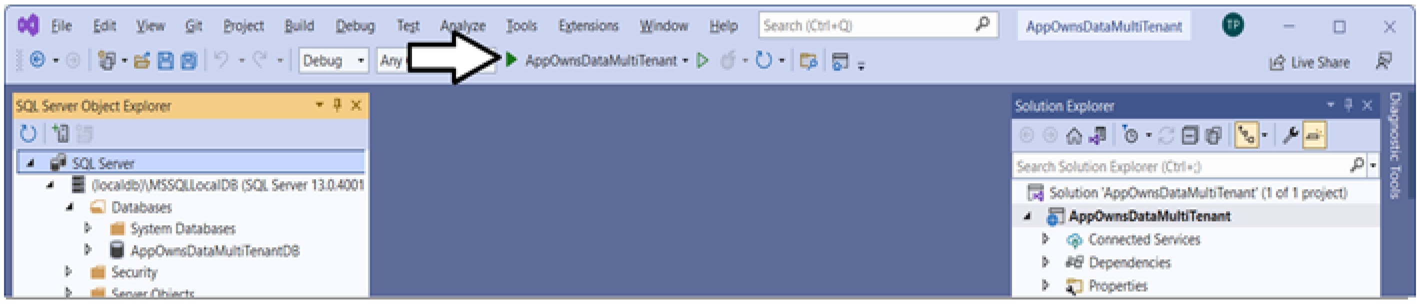
If you expand the **Tables** node for **AppOwnsDataMultiTenantDB**, you should see the two tables named **Profiles** and **Tenants**.



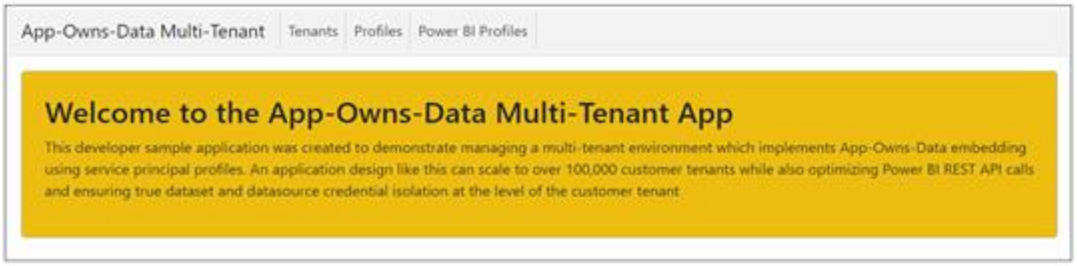
The **AppOwnsDataMultiTenantDB** database has now been set up and you are ready to run the application in the Visual Studio debugger.

Test the AppOwnsDataMultiTenant Application

Launch the **AppOwnsDataMultiTenant** application in the Visual Studio debugger by pressing the **{F5}** key or clicking the Visual Studio **Play** button with the green arrow and the caption **AppOwnsDataMultiTenant**.



When the application starts, you should see its welcome page as shown in the following screenshot.

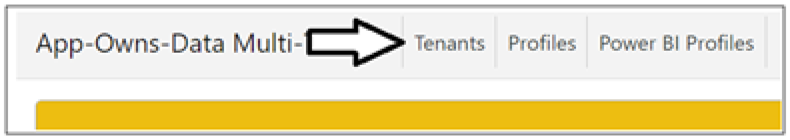


Welcome to the App-Owns-Data Multi-Tenant App

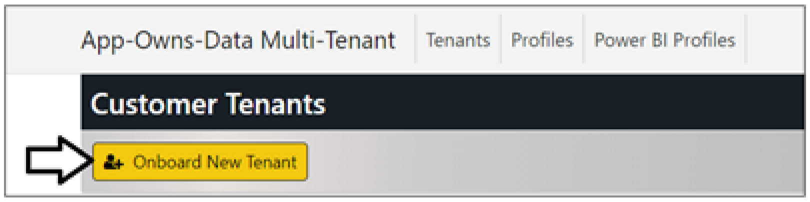
This developer sample application was created to demonstrate managing a multi-tenant environment which implements App-Owns-Data embedding using service principal profiles. An application design like this can scale to over 100,000 customer tenants while also optimizing Power BI REST API calls and ensuring true dataset and datasource credential isolation at the level of the customer tenant

Create Customer Tenants

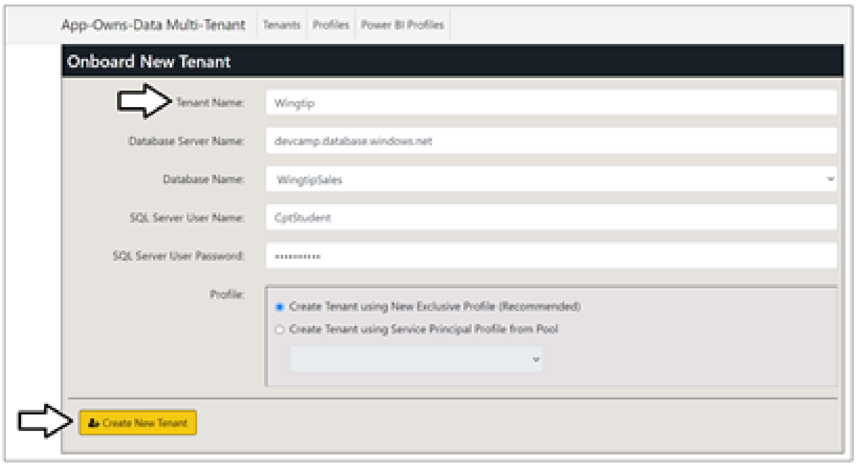
Now it's time to create your first customer tenant. Start by navigating to the **Tenants** page.



Click the **Onboard New Tenant** button to display the **Onboard New Tenant** page.



On the **Onboard New Tenant** page, enter a **Tenant Name** of **Wingtip**. Leave all the other input elements with their default values. Click to **Create New Tenant** button to begin the process of creating a new customer tenant.

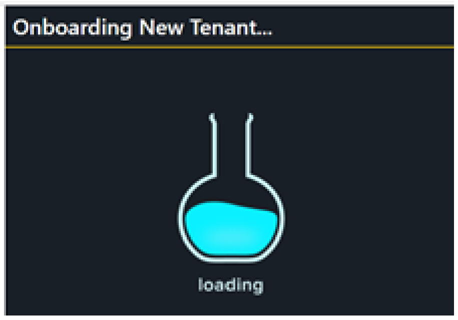


Tenant Name:	Wingtip
Database Server Name:	devcamp.database.windows.net
Database Name:	WingtipSales
SQL Server User Name:	CptStudent
SQL Server User Password:	••••••••••
Profile:	[✓ Create Tenant using New Exclusive Profile (Recommended)] Create Tenant using Service Principal Profile from Pool

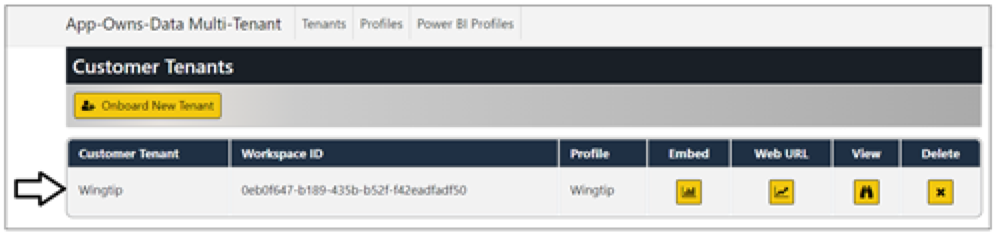
What happens when you click the **Create New Tenant** button? The **AppOwnsDataMultiTenant** application uses the Power BI REST API to create a service principal profile using same name as **Tenant Name**. After the service principal profile is created, the application then switches contexts and executes the following API calls under the identity of the new service principal profile.

- Create a new Power BI workspace
- Upload a template PBIX file to create the **Sales** dataset and the **Sales** report
- Update dataset parameters on **Sales** dataset to point to this customer's database
- Patch credentials for the SQL datasource used by the **Sales** dataset
- Start a refresh operation on the **Sales** database

While this work is going on, the application's user is shown an animated image.



After a few seconds, you should see the new customer tenant has been created.



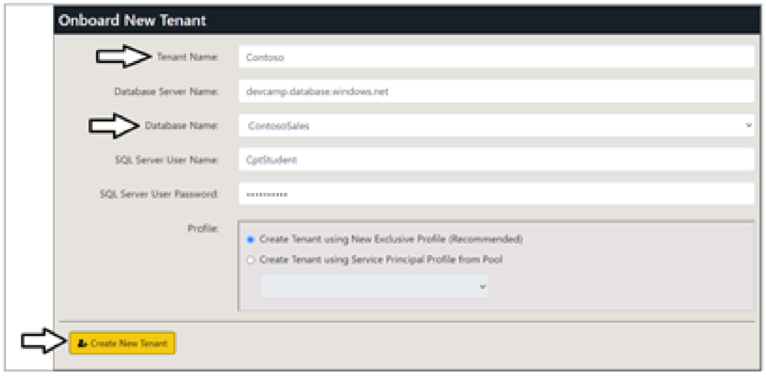
App-Owns-Data Multi-Tenant | Tenants | Profiles | Power BI Profiles

Customer Tenants

Onboard New Tenant

Customer Tenant	Workspace ID	Profile	Embed	Web URL	View	Delete
Wingtip	0eb0f647-b189-435b-b52f-f42eadfadf50	Wingtip				

Click the **Onboard New Tenant** button again to create a second tenant. This time, set **Tenant Name** to **Contoso** and select **ContosoSales** from the dropdown list for **Database Name**. After that, click **Create New Tenant**.

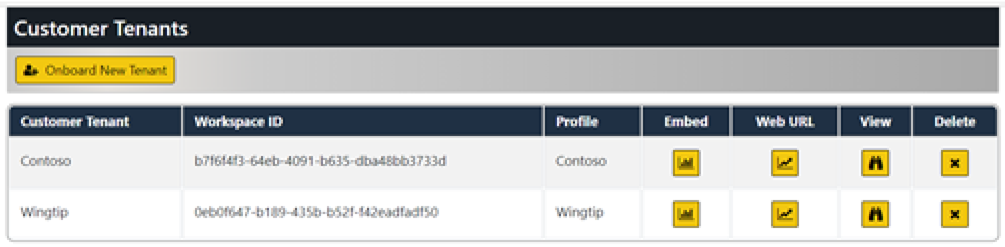


Onboard New Tenant

Tenant Name:	Contoso
Database Server Name:	devcamp.database.windows.net
Database Name:	ContosoSales
SQL Server User Name:	CptStudent
SQL Server User Password:	••••••••••
Profile:	[✓ Create Tenant using New Exclusive Profile (Recommended)] Create Tenant using Service Principal Profile from Pool

Create New Tenant

You should now have two customer tenants. Note that each tenant has been created using a different profile.

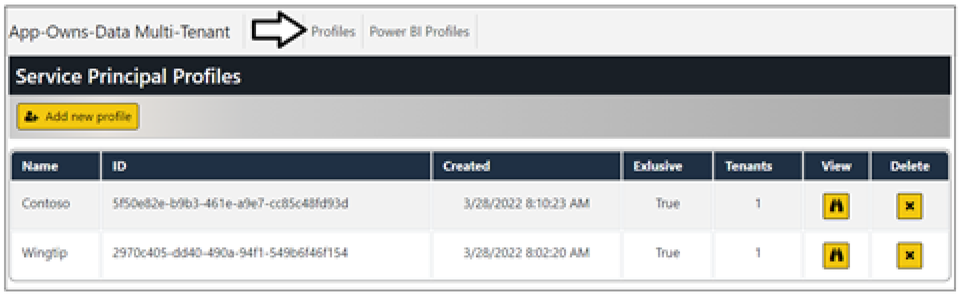


Customer Tenants

Onboard New Tenant

Customer Tenant	Workspace ID	Profile	Embed	Web URL	View	Delete
Contoso	b7f6f4f3-64eb-4091-b635-dba48bb3733d	Contoso				
Wingtip	0eb0f647-b189-435b-b52f-f42eadfadf50	Wingtip				

Click the **Profiles** link to examine each of the profiles that have been created.



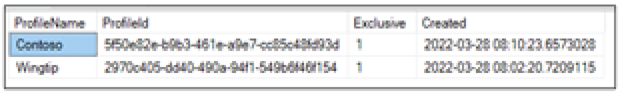
App-Owns-Data Multi-Tenant | Profiles | Power BI Profiles

Service Principal Profiles

Add new profile

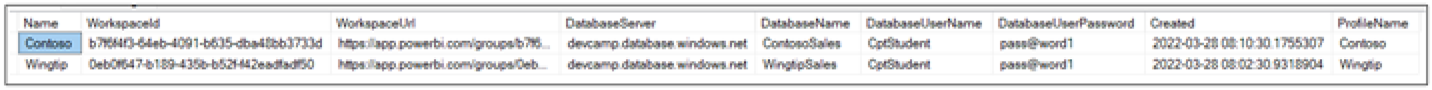
Name	ID	Created	Exlusive	Tenants	View	Delete
Contoso	5f50e82e-b9b3-461e-a9e7-cc85c48fd93d	3/28/2022 8:10:23 AM	True	1		
Wingtip	2970c405-dd40-490a-94f1-549b6f46f154	3/28/2022 8:02:20 AM	True	1		

Let's examine what has been stored in the **Profiles** table in **AppOwnsDataMultiTenantDB** database. Note that **ProfileName** column serves as the primary key of the **Profiles** table



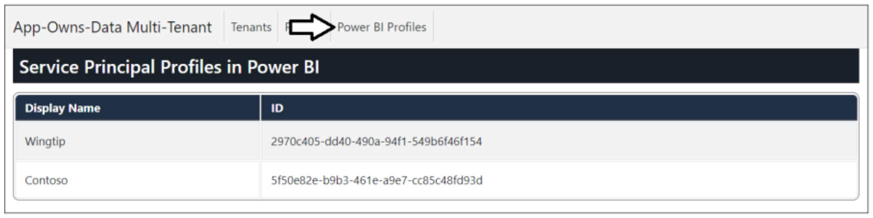
ProfileName	ProfileId	Exclusive	Created
Contoso	5f50e82e-b9b3-461e-a9e7-cc85c48fd93d	1	2022-03-28 08:10:23.6573028
Wingtip	2970c405-dd40-490a-94f1-549b6f46f154	1	2022-03-28 08:02:20.7209115

The application also added new records to the **Tenants** table. Note that the **ProfileName** column in the **Tenants** table serves as a foreign key so that each record in **Tenants** is associated with exactly one record in **Profiles**.



Name	WorkspaceId	WorkspaceUrl	DatabaseServer	DatabaseName	DatabaseUserName	DatabaseUserPassword	Created	ProfileName
Contoso	b7f6f4f3-64eb-4091-b635-dba48bb3733d	https://app.powerbi.com/groups/b7f6...	devcamp.database.windows.net	ContosoSales	CptStudent	pass@word1	2022-03-28 08:10:30.1755307	Contoso
Wingtip	0eb0f647-b189-435b-b52f-f42eadfadf50	https://app.powerbi.com/groups/0eb...	devcamp.database.windows.net	WingtipSales	CptStudent	pass@word1	2022-03-28 08:02:30.9318904	Wingtip

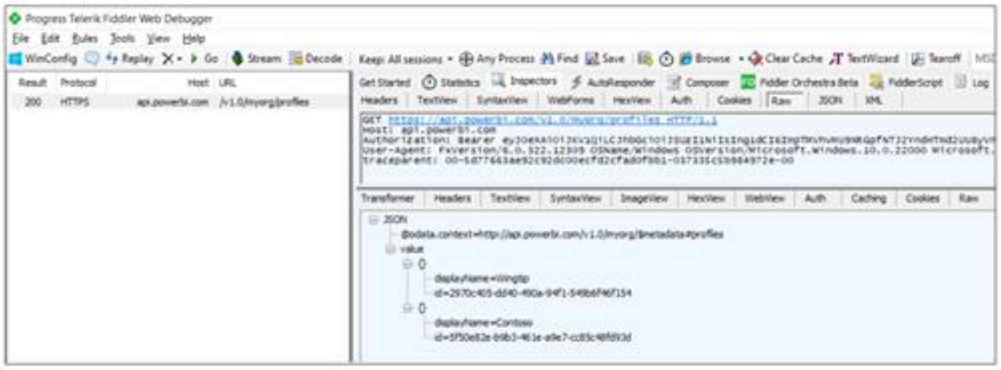
Now click the **Power BI Profiles** link. When you navigate to this page, the application calls the **Get Profiles** operation of the Power BI REST API to retrieve all the profiles that have been created by the application's service principal.



Service Principal Profiles in Power BI

Display Name	ID
Wingtip	2970c405-dd40-490a-94f1-549b6f46f154
Contoso	5f50e82e-b9b3-461e-a9e7-cc85c48fd93d

If you use a developer tool such as Fiddler, you can inspect the call to **Get Profiles** to see the JSON response.


Progress Telerik Fiddler Web Debugger
File Edit Rules Tools View Help
WinConfig Replay Go Stream Decode Keep: All sessions Any Process Find Save Browse Clear Cache TextWizard Tearoff
Get Started Statistics Inspectors AutoResponder Composer Fiddler Orchestra Beta FiddlerScript Log
Headers TextView SyntaxView WebForms HexView Auth Cookies Raw JSON XML
Transformer Headers TextView SyntaxView ImageView HexView WebView Auth Caching Cookies Raw

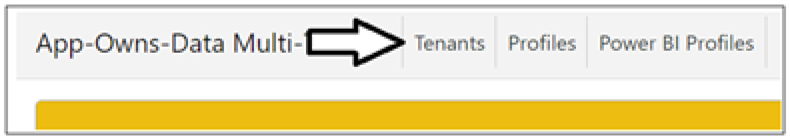
Result	Protocol	Host	URL
200	HTTPS	api.powerbi.com	/v1.0/myorg/profiles

```
GET https://api.powerbi.com/v1.0/myorg/profiles HTTP/1.1
Host: api.powerbi.com
Authorization: Bearer [illegible]
User-Agent: FxVersion/6.0.322.12309 OSName/Windows OSVersion/Microsoft.Windows.10.0.22000 Microsoft.
traceparent: [illegible]
```

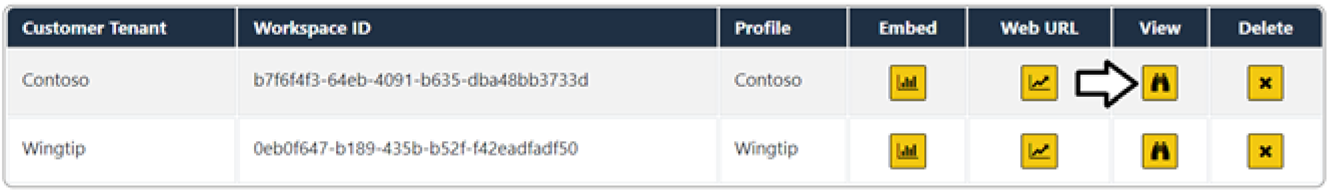
```
JSON
  @odata.context=http://api.powerbi.com/v1.0/myorg/$metadata#profiles
  value
    0
      displayName=Wingtip
      id=2970c405-dd40-490a-94f1-549b6f46f154
    0
      displayName=Contoso
      id=5f50e82e-b9b3-461e-a9e7-cc85c48fd93d
```

Access Customer Tenants

Now that you have created two tenants, it's time to access their content. Navigate back to the **Tenants** page.

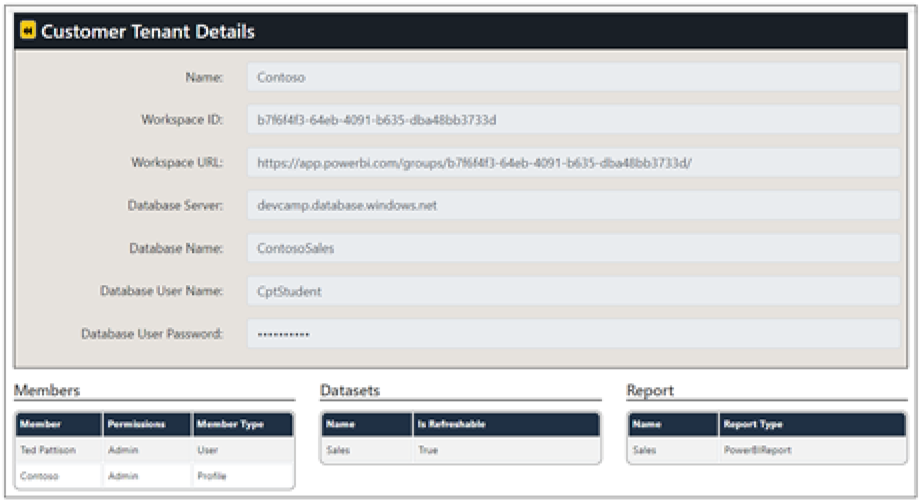


Click on the **View** button for a specific tenant on the **Tenants** page to drill into the **Tenant Details** page.



Customer Tenant	Workspace ID	Profile	Embed	Web URL	View	Delete
Contoso	b7f6f4f3-64eb-4091-b635-dba48bb3733d	Contoso	📊	📈	🔭	✖
Wingtip	0eb0f647-b189-435b-b52f-f42eadfadf50	Wingtip	📊	📈	🔭	✖

The **Tenant Details** page displays Power BI workspace details including its members, datasets and reports.



Customer Tenant Details

Name:	Contoso
Workspace ID:	b7f6f4f3-64eb-4091-b635-dba48bb3733d
Workspace URL:	https://app.powerbi.com/groups/b7f6f4f3-64eb-4091-b635-dba48bb3733d/
Database Server:	devcamp.database.windows.net
Database Name:	ContosoSales
Database User Name:	CptStudent
Database User Password:	••••••••••

Members

Member	Permissions	Member Type
Ted Pattison	Admin	User
Contoso	Admin	Profile

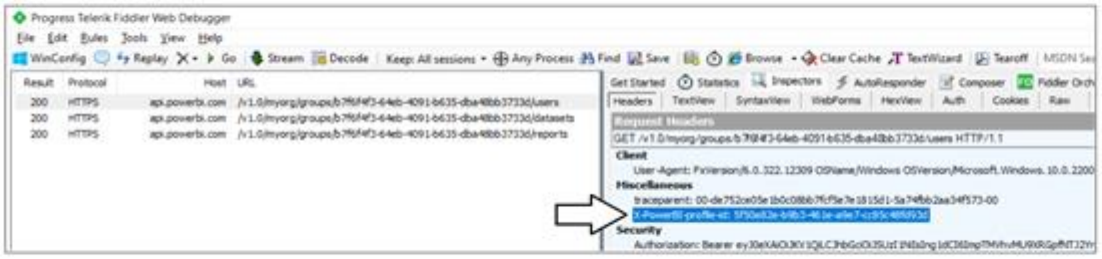
Datasets

Name	Is Refreshable
Sales	True

Report

Name	Report Type
Sales	PowerBIReport

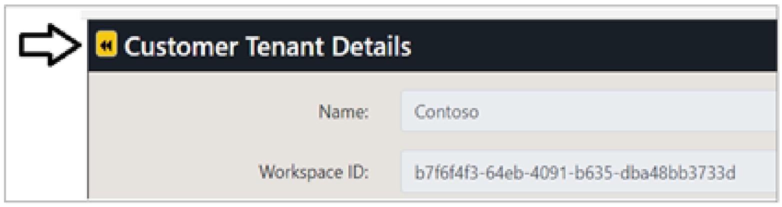
If you use a developer tool such as Fiddler, you can inspect the API call to retrieve workspace members as well as the API calls to retrieve collections for datasets and reports in the target workspace. Note that each of these calls is made under the identity of a service principal profile as evidenced by the existence of the **X-PowerBI-profile-id** header.


Progress Telerik Fiddler Web Debugger
File Edit Rules Tools View Help
WinConfig Replay Go Stream Decode Keep: All sessions Any Process Find Save Browse Clear Cache TextWizard Tearoff MSDN Sea
Get Started Statistics Inspectors AutoResponder Composer Fiddler Orch
Headers TextView SyntaxView WebForms HexView Auth Cookies Raw

Result	Protocol	Host	URL
200	HTTPS	api.powerbi.com	/v1.0/myorg/groups/b7f6f4f3-64eb-4091-b635-dba48bb3733d/users
200	HTTPS	api.powerbi.com	/v1.0/myorg/groups/b7f6f4f3-64eb-4091-b635-dba48bb3733d/datasets
200	HTTPS	api.powerbi.com	/v1.0/myorg/groups/b7f6f4f3-64eb-4091-b635-dba48bb3733d/reports

```
Request Headers
GET /v1.0/myorg/groups/b7f6f4f3-64eb-4091-b635-dba48bb3733d/users HTTP/1.1
Client
    User-Agent: FxVersion/6.0.322.12309 OSName/Windows OSVersion/Microsoft.Windows.10.0.2200
Miscellaneous
    traceparent: 00-de752ce05e1b0c08bb7fcf5e7e1815d1-5a74fbb2aa34f573-00
    X-PowerBI-profile-id: 5f50e82e-b9b3-463e-a8e7-cc95c4850930
Security
    Authorization: Bearer eyJ0eXAiOiJKV1QiLCJhbGciOiJSUzI1NiIsIng1dCI6ImpTMVhvMU9XRGpfNTJ2Y
```

Click on the back arrow to return to the **Tenants** page.

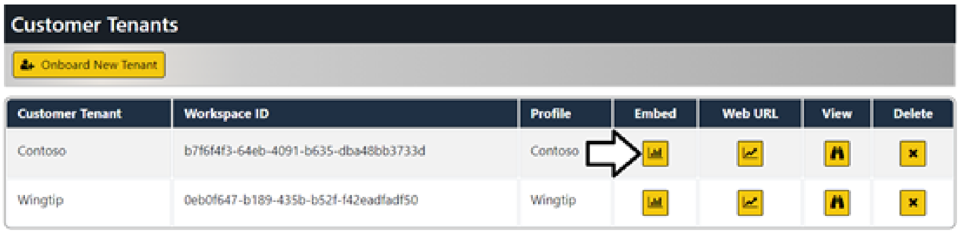


Customer Tenant Details

Name:	Contoso
Workspace ID:	b7f6f4f3-64eb-4091-b635-dba48bb3733d

Embed Reports

Now it's time to make use of the **AppOwnsDataMultiTenant** application's ability to embed reports. On the **Tenants** page, click the **Embed** button for the **Contoso** tenant to navigate to the **Embed** page.

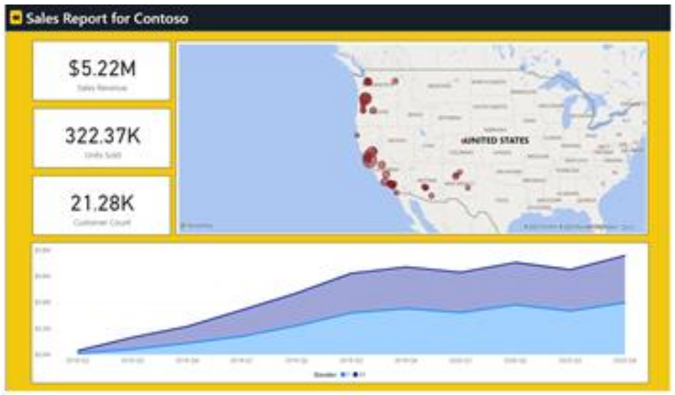


Customer Tenants

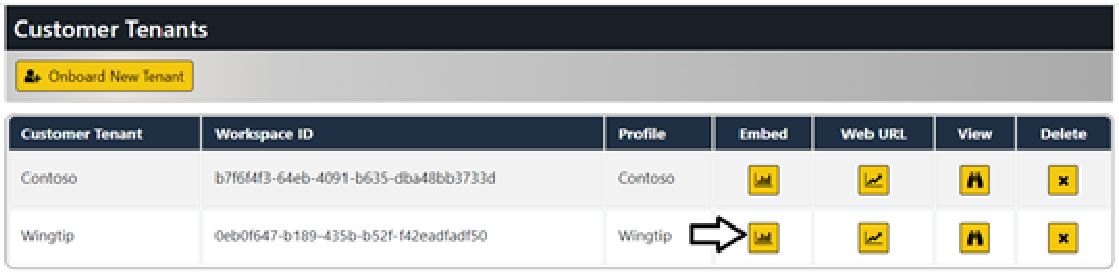
Onboard New Tenant

Customer Tenant	Workspace ID	Profile	Embed	Web URL	View	Delete
Contoso	b7f6f4f3-64eb-4091-b635-dba48bb3733d	Contoso				
Wingtip	0eb0f647-b189-435b-b52f-f42eadfadf50	Wingtip				

You should now see a page with an embedded report for the Contoso tenant.



Click on the back arrow button to return to the **Tenants** page and click the **Embed** button for the Wingtip tenant.

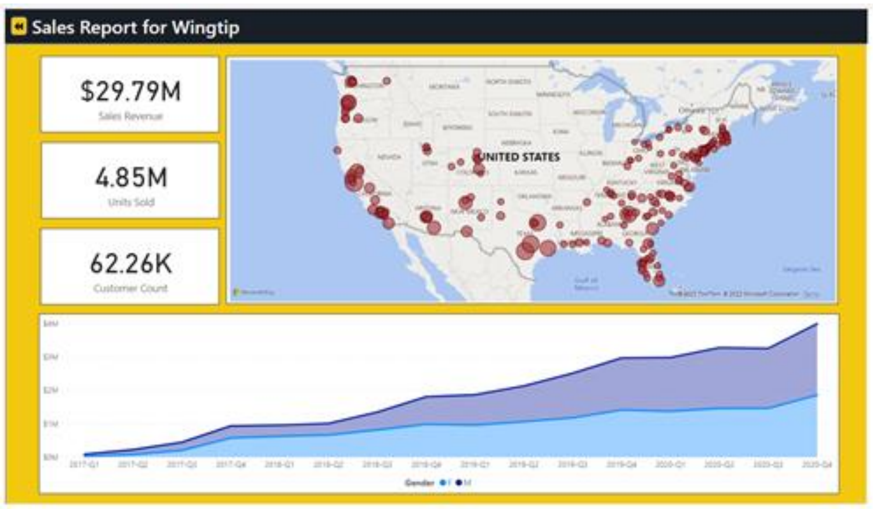


Customer Tenants

Onboard New Tenant

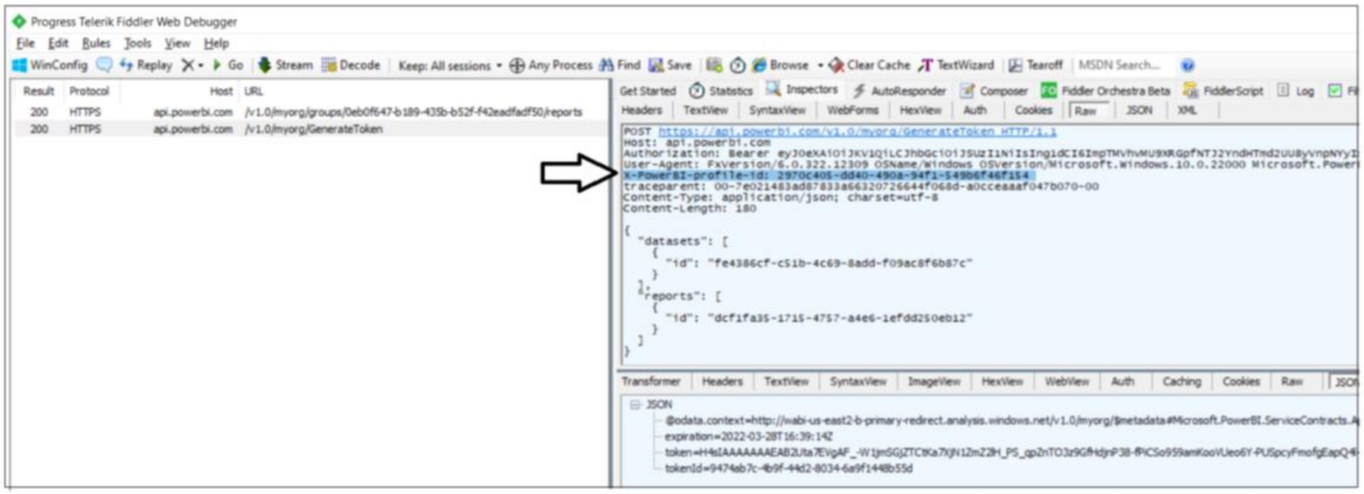
Customer Tenant	Workspace ID	Profile	Embed	Web URL	View	Delete
Contoso	b7f6f4f3-64eb-4091-b635-dba48bb3733d	Contoso				
Wingtip	0eb0f647-b189-435b-b52f-f42eadfadf50	Wingtip				

You should now see that the application is able to embed a report from any customer tenant.



When a user navigates to the **Embed** page for a customer tenant, the application must determine which service principal profile was used to create the target workspace. The application performs a lookup in the **AppOwnsDataMultiTenantDB** database to determine which service principal profile id is associated with the target workspace. The application is then able to query for workspace artifacts and to generate the embed token using that service principal profile's identity.

If you use a developer tool such as Fiddler, you can see that calls to access a workspace and to generate embed tokens includes the **PowerBI-profile-id** header as shown in the following screenshot.


Progress Telerik Fiddler Web Debugger
File Edit Rules Tools View Help
WinConfig Replay Go Stream Decode Keep: All sessions Any Process Find Save Browse Clear Cache TextWizard Tearoff MSDN Search...
Get Started Statistics Inspectors AutoResponder Composer Fiddler Orchestra Beta FiddlerScript Log
Headers TextView SyntaxView WebForms HexView Auth Cookies Raw JSON XML
Transformer Headers TextView SyntaxView ImageView HexView WebView Auth Caching Cookies Raw JSON

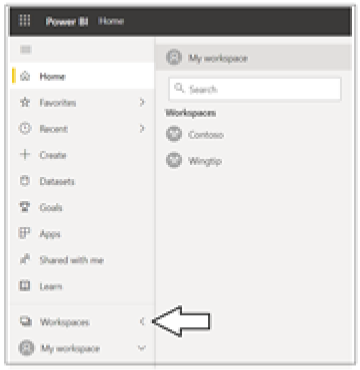
Result	Protocol	Host	URL
200	HTTPS	api.powerbi.com	/v1.0/myorg/groups/0eb0f647-b189-435b-b52f-f42eadfadf50/reports
200	HTTPS	api.powerbi.com	/v1.0/myorg/GenerateToken

```
POST https://api.powerbi.com/v1.0/myorg/GenerateToken HTTP/1.1
Host: api.powerbi.com
Authorization: Bearer eyJ0eXAiOiJKV1QiLCJhbGciOiJSUzI1NiIsIng1dCI6ImpTMVhvMU9XRGpfNTJ2YndHTmd2UUByVnpNYyI
User-Agent: FxVersion/6.0.322.12309 OSName/Windows OSVersion/Microsoft.Windows.10.0.22000 Microsoft.Power
X-PowerBI-profile-id: 2970c405-dd40-490a-94f1-549b6f46f154
traceparent: 00-7e021483ad87833a66320726644f068d-a0cceaaaf047b070-00
Content-Type: application/json; charset=utf-8
Content-Length: 180

{
  "datasets": [
    {
      "id": "fe4386cf-c51b-4c69-8add-f09ac8f6b87c"
    }
  ],
  "reports": [
    {
      "id": "dcf1fa35-1715-4757-a4e6-1efdd250eb12"
    }
  ]
}
```

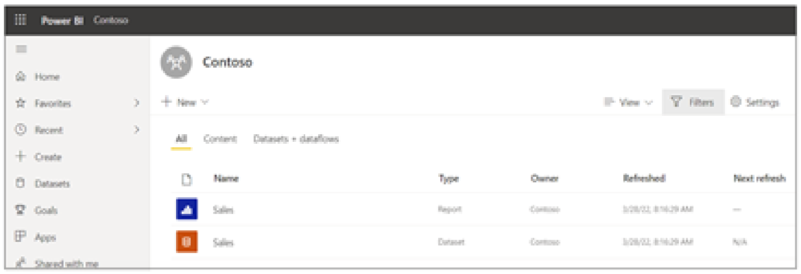
```
JSON
  @odata.context=http://wabi-us-east2-b-primary-redirect.analysis.windows.net/v1.0/myorg/$metadata#Microsoft.PowerBI.ServiceContracts.A
  expiration=2022-03-28T16:39:14Z
  token=H4sIAAAAAAAEAB2Uta7EVgAF_-W1jmSGjZTCtKa7XjN1ZmZ2H_PS_qpZnTO3z9GfHdjnP38-fPiCSo959amKooVUeo6Y-PUSpcyFmofgEapQ4
  tokenId=9474ab7c-4b9f-44d2-8034-6a9f1448b55d
```

Inspect the Power BI Workspaces

If you're curious about what's been created in Power BI, you can see for yourself by navigating to the Power BI Service portal at https://app.powerbi.com. You should be able to see and navigate to any of the Power BI workspaces that have been created by the **AppOwnsDataMultiTenant** application.

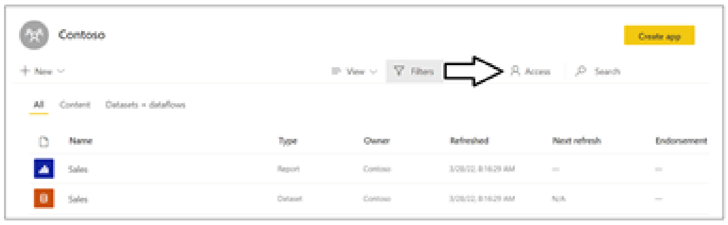


Navigate to one of these workspaces such as the workspace named **Contoso**.



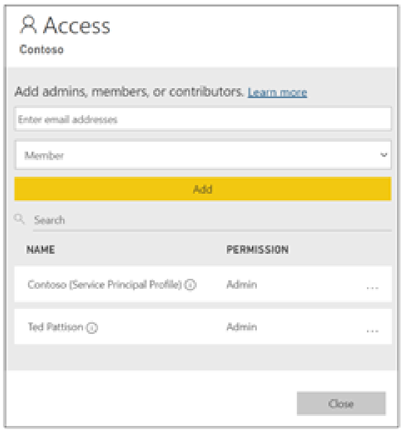
Name	Type	Owner	Refreshed	Next refresh
Sales	Report	Contoso	3/28/22, 8:16:29 AM	—
Sales	Dataset	Contoso	3/28/22, 8:16:29 AM	N/A

Click the **Access** button to display the **Access** pane for the Contoso workspace.



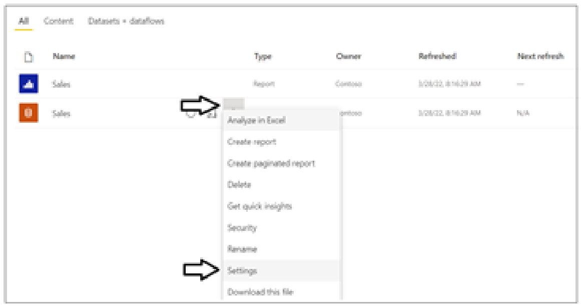
Name	Type	Owner	Refreshed	Next refresh	Endorsement
Sales	Report	Contoso	3/28/22, 8:16:29 AM	—	—
Sales	Dataset	Contoso	3/28/22, 8:16:29 AM	N/A	—

On the workspace **Access** pane, you should see two members including your user account and a service principal profile.

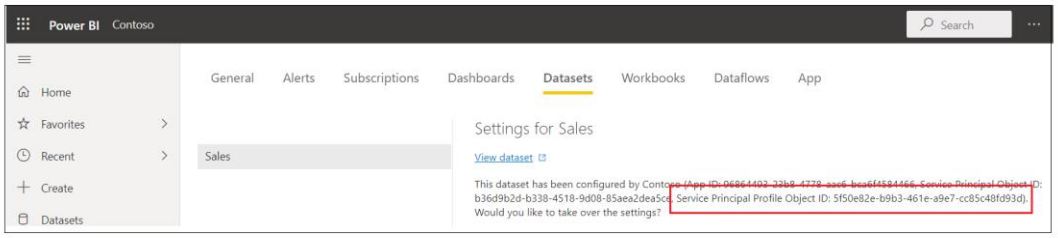


NAME	PERMISSION
Contoso (Service Principal Profile)	Admin
Ted Pattison	Admin

Close the **Access** pane and then drill into the **Setting** page for the dataset named **Sales**.



You should be able to verify that the **Sales** dataset has been configured by a service principal profile which is evidenced by the **Service Principal Profile Object ID** as shown in the following screenshot.



Settings for Sales

View dataset

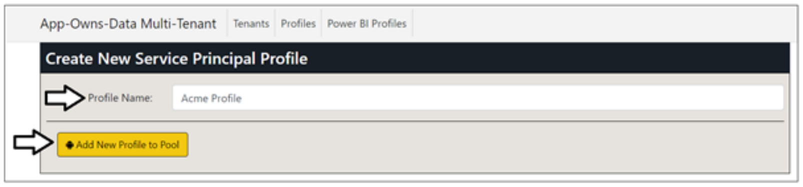
This dataset has been configured by Contoso (App ID: 06864492-23b8-4778-aac6-bca6f4584466, Service Principal Object ID: b36d9b2d-b338-4518-9d08-85aea2dea5ce, Service Principal Profile Object ID: 5f50e82e-b9b3-461e-a9e7-cc85c48fd93d). Would you like to take over the settings?

Create Multiple Workspaces with a Single Service Principal Profile

At this point you have used the **AppOwnsDataMultiTenant** application to create customer tenants that each have their own distinct service principal profile. This is generally considered as a best practice to maintain a one-to-one relationship between service principal profiles and customer tenants as it will provide the best performance and the most secure level of isolation.

However, there could be less-common scenarios where you'd like to have a single service principal profile create and manage two or more customer tenants. For example, let's say you need to create two separate customer tenants for different divisions of a single organization. You will now test out how the **AppOwnsDataMultiTenant** application allows for this scenario.

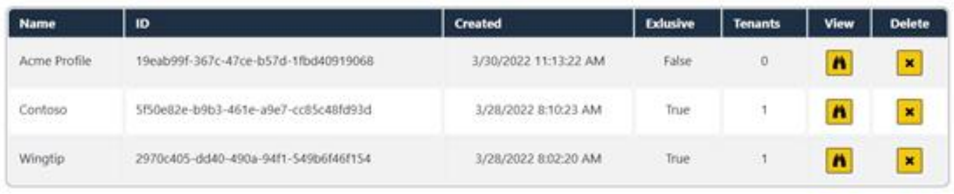
Click on the **Profile** link to navigate to the **Profiles** page and then click the **Add new profile** button. On the **Create New Profile** page, enter a **Profile Name** of **Acme Profile** and click **Add New Profile to Pool** button.



Create New Service Principal Profile

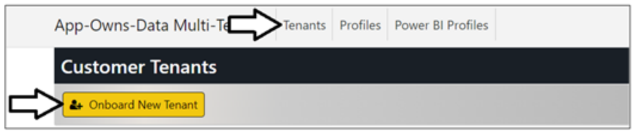
Profile Name: Acme Profile

You should see a new profile named **Acme Profile** has been created with **Exclusive** equals **False** and **Tenants** equals **0**.



Name	ID	Created	Exlusive	Tenants	View	Delete
Acme Profile	19eab99f-367c-47ce-b57d-1fbd40919068	3/30/2022 11:13:22 AM	False	0		
Contoso	5f50e82e-b9b3-461e-a9e7-cc85c48fd93d	3/28/2022 8:10:23 AM	True	1		
Wingtip	2970c405-dd40-490a-94f1-549b6f46f154	3/28/2022 8:02:20 AM	True	1		

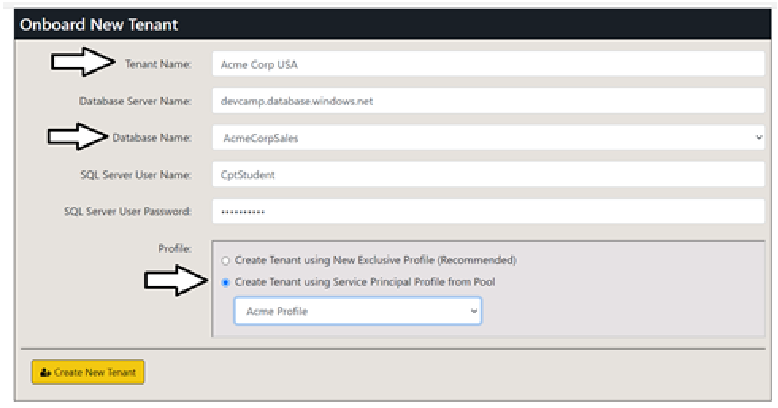
The **Exclusive** value is set to **False** because the profile can be used to create multiple tenants. The **Tenants** value equals **0** because this profile is not yet associated with any tenants. Now it's time to create two tenants for this profile. Click the **Tenants** link to navigate to the **Tenants** page and then click the **Onboard New Tenant** button.



On the **Onboard New Tenant** page…

1. Enter a **Tenant Name** of **Acme Corp USA**.
2. Select a **Database Name** of **AcmeCorpSales**.
3. In the **Profile** section, select the option to **Create Tenant using Service Principal Profile from Pool**
4. Select the pre-existing profile named **Acme Profile**.

When your page matches the following screenshot, click the **Create New Tenant**.



Onboard New Tenant

Tenant Name: Acme Corp USA

Database Server Name: devcamp.database.windows.net

Database Name: AcmeCorpSales

SQL Server User Name: CptStudent

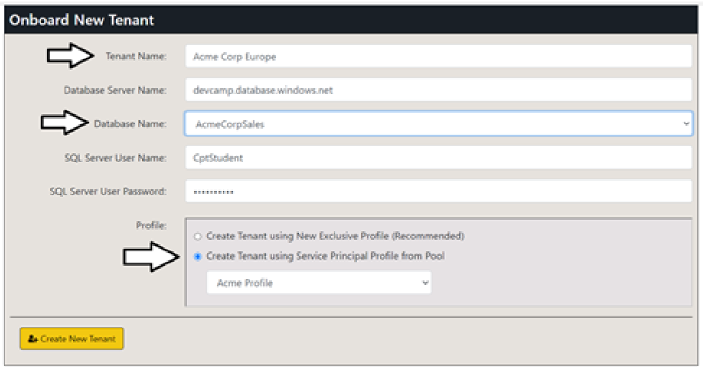
SQL Server User Password: ••••••••••

Profile:
○ Create Tenant using New Exclusive Profile (Recommended)
● Create Tenant using Service Principal Profile from Pool
Acme Profile

Now you will create a second tenant which uses the profile named **Acme Profile**. On the **Tenants** page, click the **Onboard New Tenant** button to display the **Onboard New Tenant** page.

On the **Onboard New Tenant** page…

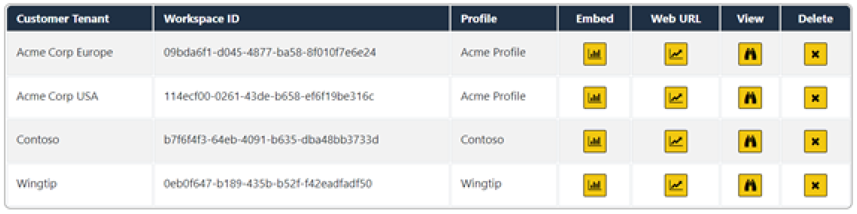
1. Enter a **Tenant Name** of **Acme Corp Europe**
2. Select a **Database Name** of **AcmeCorpSales**
3. Select the option to **Create Tenant using Service Principal Profile from Pool**
4. Select **Acme Profile**.
5. Click **Create New Tenant**.



Onboard New Tenant

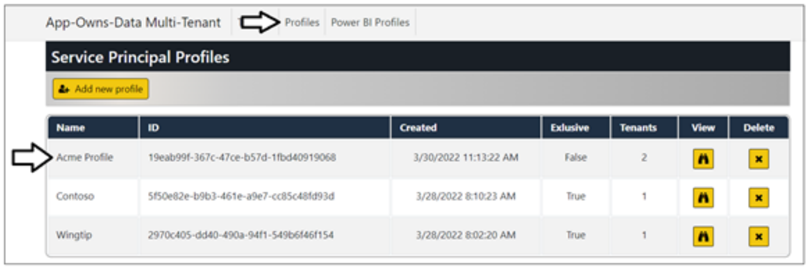
Tenant Name:	Acme Corp Europe
Database Server Name:	devcamp.database.windows.net
Database Name:	AcmeCorpSales
SQL Server User Name:	CptStudent
SQL Server User Password:	••••••••••
Profile:	○ Create Tenant using New Exclusive Profile (Recommended) ● Create Tenant using Service Principal Profile from Pool Acme Profile

You should see that you have now created two separate customer tenants that are both associated with **Acme Profile**.



Customer Tenant	Workspace ID	Profile	Embed	Web URL	View	Delete
Acme Corp Europe	09bda6f1-d045-4877-ba58-8f010f7e6e24	Acme Profile				
Acme Corp USA	114ecf00-0261-43de-b658-ef6f19be316c	Acme Profile				
Contoso	b7f6f4f3-64eb-4091-b635-dba48bb3733d	Contoso				
Wingtip	0eb0f647-b189-435b-b52f-f42eadfadf50	Wingtip				

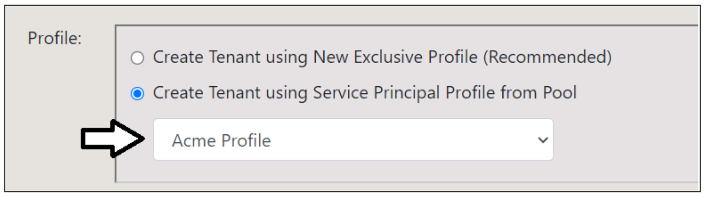
Click the **Profile** link to navigate to the **Profiles** page. If you inspect the profile named **Acme Profile**, you can see it now has a tenant count of **2**.



Service Principal Profiles

Name	ID	Created	Exlusive	Tenants	View	Delete
Acme Profile	19eab99f-367c-47ce-b57d-1fbd40919068	3/30/2022 11:13:22 AM	False	2		
Contoso	5f50e82e-b9b3-461e-a9e7-cc85c48fd93d	3/28/2022 8:10:23 AM	True	1		
Wingtip	2970c405-dd40-490a-94f1-549b6f46f154	3/28/2022 8:02:20 AM	True	1		

Note that each profile has a value for the **Exclusive** property. This property serves two purposes. First, it's used to determine which profiles are added to the dropdown list of pooled profiles on the **Onboard New Tenant** page. This dropdown list will only contain profiles with an **Exclusive** property value of **False**.



Profile:
○ Create Tenant using New Exclusive Profile (Recommended)
● Create Tenant using Service Principal Profile from Pool
Acme Profile

The second purpose of the **Exclusive** property is to determine whether to automatically delete a service principal profile from the Power BI Service and from the **AppOwnsDataMultiTenantDB** database when a customer tenant is deleted. When you delete a customer tenant that is associated with an exclusive profile, this profile is automatically deleted along with the customer tenant and it's underlying Power BI workspace.