# Welcome to SPA

You’ve heard of SPA – “single page application” – and wondered what it is. While you could read about it, you’d rather experience it for yourself. But who has time to download a sample? Well if you’ve got Visual Studio, you’ll have a SPA up and running in less than 60 seconds with the “ASP.NET MVC 4 Breeze Single Page Application” template.

[](http://www.breezejs.com/sites/all/images/spa-template/ZephyrRunning.png)

[[http:/www.breezejs.com/sites/all/images/spa-template/ZephyrRunning.png](http://www.breezejs.com/sites/all/images/spa-template/ZephyrRunning.png)]

# What is the Breeze SPA Template?

Most project templates generate an application skeleton. You put flesh on those bones by adding your code and eventually deliver a working application.

The ASP.NET MVC 4 SPA template is different. It generates a sample application for you to study. It demonstrate what a SPA is and many of the techniques for building a SPA.

The Breeze SPA Template is variation on the ASP.NET SPA template. It generates an application with the same user experience but a different implementation, one with Breeze handling data management.

The ASP.NET template app makes service requests with raw jQuery AJAX, which is perfectly adequate for this simple demo. More sophisticated apps have more demanding data management requirements. For example, most applications

* query and re-query the server during an extended user session
* add query filters, sorts, and paging
* share the same data across multiple screens
* accumulate changes to many objects, then save them as a single transaction with the click of a “Save” button
* validate changes on the client so the user can correct mistakes before committing changes to the database.

The BreezeJS library handles these chores for you, freeing you to develop that application logic and user experience that matter most. Breeze is an open source library for building full-blown, rich data applications in JavaScript and HTML, the kinds of apps that have historically been delivered as stand-alone desktop applications.

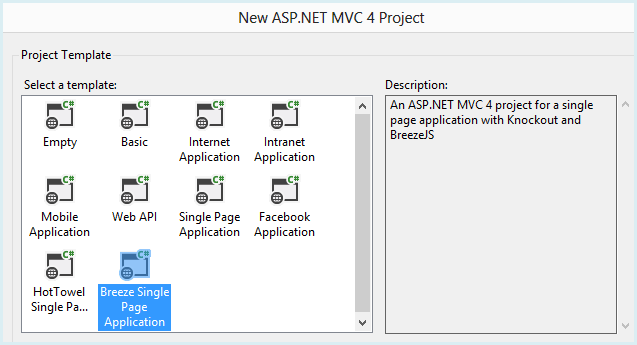
This Breeze SPA template helps you take that first crucial step toward a more robust data management infrastructure. It produces a sample Todo application that is outwardly identical to the ASP.NET template app. On the inside, it replaces the AJAX data layer with Breeze, so you can compare the two approaches side-by-side. Of course it barely touches the potential of a Breeze application. But you’ll see straight away how Breeze works and how little is required to make that transition.

Let’s get started.

# File | New

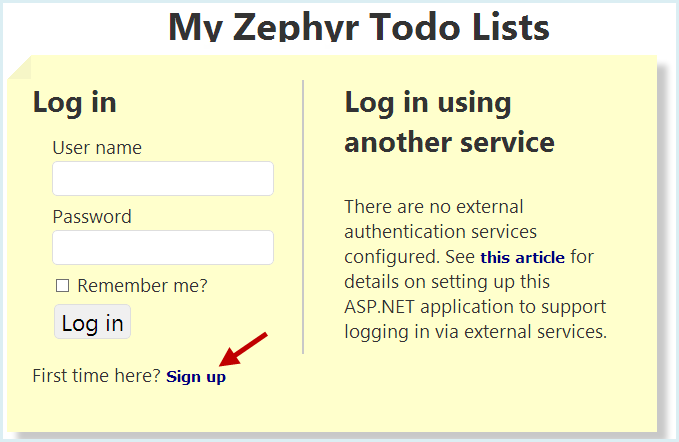
After you’ve installed the Visual Studio Extension (VSIX) file, the Breeze SPA template is waiting for you. From the Visual Studio menu choose “File | New | Project”. Pick “Visual C# | Web | ASP.NET MVC 4 Web Application”. Give your app a name; here we call it “Zephyr”.

A dialog appears with a list of templates; choose the “Breeze Single Page Application”.

[](http://www.breezejs.com/sites/all/images/spa-template/SelectBreezeSpaTemplate.png)

[SelectBreezeSpaTemplate.png]

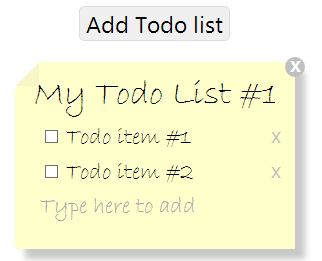
After a few moments of NuGet package loading and project generation, you can press Ctrl-F5 to build and run it without debugging (F5 with debugging if you prefer). A browser window appears and you’ll be invited to log in.

[](http://www.breezejs.com/sites/all/images/spa-template/ZephyrLogin.png)

[ZephyrLogin.png]

You don’t have an account yet so click “Sign up”. A new page glides into view where you can enter your username and a password. You are still in the world of MVC. The login and registration pages are MVC pages.

When you complete and submit the registration form, the server generates a TodoList with two items for your account. Then it presents them to you on a yellow note.



[TodoList.png]

Now you are in the land of SPA. Everything you see and experience while manipulating Todos is rendered and managed on the client with the help of Knockout and Breeze.

Explore the app as a user … but with a developer’s eye. Open the developer tools (F12) and switch to the “Network” tab (in IE, click “Start capturing”). Now try the following:

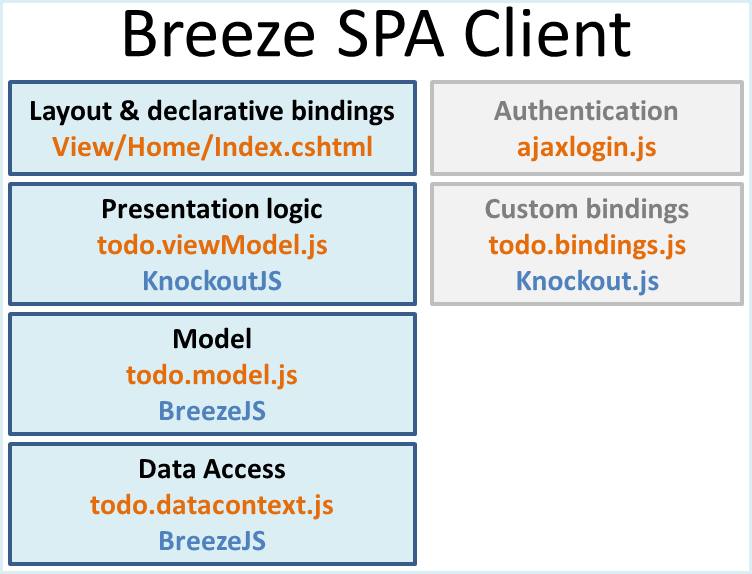
* Add a new Todo item.
* Click the label and edit the Todo item title
* Check a checkbox to mark the item done; notice that the textbox is disabled, preventing further title change.
* Click the ‘x’ to the right of the label; the item disappears and is deleted from the database
* Pick another item and clear its title; you’ll get a validation error telling you the title is required; after a brief pause, the previous title is restored.
* Type in a ridiculously long title; you’ll get a different validation error tell you the title is too long.
* Click the “Add Todo List” button; a new list appears to the left of the previous list.
* Play with the TodoList title, triggering its required and length validations.
* Clicking in the title textbox clears the error message.
* Click the “x” in the circle in the upper right corner; you’ve deleted the TodoList and its todos.

The validations were performed client-side by Breeze. Validation attributes on the server model classes were propagated to the client and executed automatically before the client contacts the server.

Review the network traffic. Notice that there were no calls to the server when Breeze detected an error. Notice that each valid change resulted in a post to “/api/Todo/SaveChanges”. Breeze bundles the changes and sends them together as a single request to the Web API controller’s “SaveChanges” method. That’s different from the traffic you may remember from running the ASP.NET SPA template which makes PUT, POST, and DELETE requests for each item individually.

# Peek inside

There’s a client and a server side to this application. The client-side SPA stack consists of a little HTML and a combination of application JavaScript modules (in the “/Scripts/app” folder) plus 3rd party JavaScript libraries (in the “Scripts” folder) as portrayed in the following diagram:

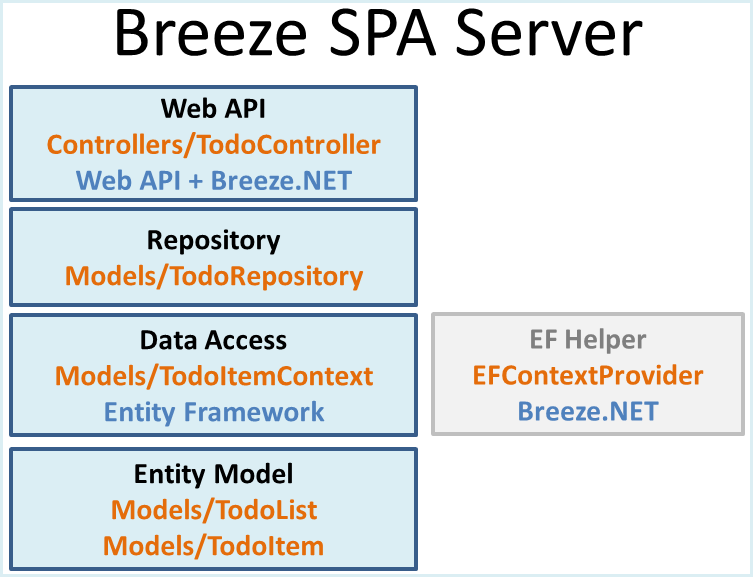


[ClientArchitecture.png]

If you’ve investigated the ASP.NET SPA template this should look very familiar … intentionally so. Focus on the blue boxes. The UI architecture is Model-View-ViewModel (MVVM) in which the HTML widgets of the View are cleanly separated from the supporting presentation code in the ViewModel. A data binding system – Knockout in this case – helps coordinate the View and ViewModel so that each can do its job without intimate knowledge of the other.

The Model encapsulates the Todo data. Entities in the Model are constructed by Breeze with Knockout observable properties so that they can be bound directly to widgets in the View. The ViewModel asks the “datacontext” to acquire and save the model entities. The datacontext delegates most of the work to Breeze.

The supporting server-side stack consists of some developer code and three principle .NET libraries: Web API, Entity Framework, and Breeze.NET … as summarized in this diagram:



[ServerArchitecture.png]

The basic architecture is the same as you’ve seen in the ASP.NET SPA template. The implementation is much simpler: the DTOs were deleted and most of the Entity Framework details have been delegated to Breeze.NET.

# What Next

We suggest that you explore the code, guided by the extensive discussion of both the client and the server stacks on the Breeze website.

You might try playing with the Breeze client-side query; add some filters and sorts. You might add more model properties and more entities to get a better feel of end-to-end SPA app development. Some folks will tear out the Todo model and replace it with a model of their own. This is a good learning exercise.

Eventually you’ll be ready for the next big step: adding client-side screens and navigating among them. You’ll leave this SPA template behind and turn to a more complete SPA stack such as [John Papa’s Hot Towel](https://github.com/johnpapa/HotTowel#readme) which adds Durandal to the Breeze and Knockout mix that you first met here in the Breeze SPA template.

# Solution overview

The Breeze SPA template generates a single-project, web application solution with structure and contents that hew closely to the ASP.NET MVC 4 “Single Page Application” template.

That is entirely intentional. A primary goal of the Breeze template is to demonstrate ***how little you must change*** to add data-rich Breeze development. We’ll concentrate on differences but we can’t do that in a vacuum. So we’ll also cover the commonalities as we go, leaving the deeper details to others [#link to notes with links to resources].

|  |  |
| --- | --- |
|  | **App\_Data** – The *Todo* LocalDb database files; “Show all files” to see them.  **App\_Start** – Server-side web application configuration classes  **Areas** – MVC location for Web API help  **Content** – CSS and theme images  **Controllers** – both MVC page and Web API data controllers  **Filters** – A Web API attribute applied to the AccountController that creates and initializes the database when not found.  **Models** – The server-side, CLR model classes  **Scripts** – The application and 3rd party JavaScript files that drive the client experience  **Views** - HTML for both MVC and SPA views |

[ZephyrSolution.png]

The Zephyr project defines an MVC 4 web application that serves content and data. Most of the 170+ files never leave the server. What’s really interesting about SPA happens on the client. We’ll look at the client first and then circle back to the server

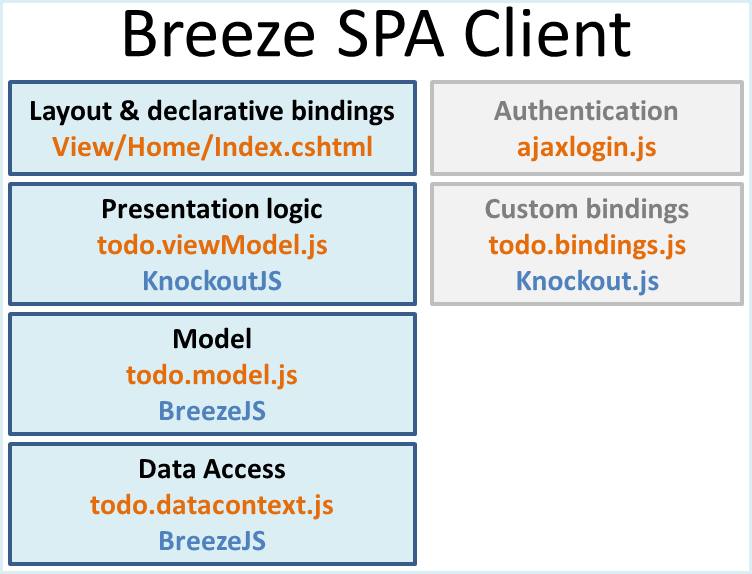
# The Client

In a typical session about 30 file make it over to the browser: 14 style sheets, 15 scripts, and 1 HTML file. We can ignore the style sheets; all but two are themes from jQuery-UI.

Ten of the fifteen scripts are 3rd party libraries:

* [jQuery](http://jquery.com/) (5 libraries and plugins)
* [breezeJS](http://www.breezejs.com/documentation/download) – for data management
* [breeze.savequeuing.js](http://www.breezejs.com/documentation/download) – a Breeze plugin to handle concurrent client save requests.
* [knockoutJS](http://knockoutjs.com/) – for data binding
* [modernizr](http://modernizr.com/) – to reduce the effects of browser differences
* [q.js](https://github.com/kriskowal/q#readme) – a promises library to simplify asynchronous programming, required by Breeze

That leaves an HTML file and the five application scripts located in the ***Scripts/app*** folder.



[ClientArchitecture.png]

We’ll brush past two of the scripts which come to us unadulterated from the ASP.NET SPA template.

|  |  |
| --- | --- |
| **ajaxlogin** | a traditional jQuery JavaScript file in support of the MVC views devoted to authentication tasks: login, logout, and account control. It has no role in the SPA page. |
| **Todo.bindings** | custom Knockout bindings to sweeten the user experience |

The four files in blue define the SPA application proper.

### Views/Home/Index.cshtml

*Index.cshtml* is the SPA shell page. Its main content is divided into pre- and post-authentication views. We won’t cover the pre-authentication views which are well documented for the ASP.NET SPA template.

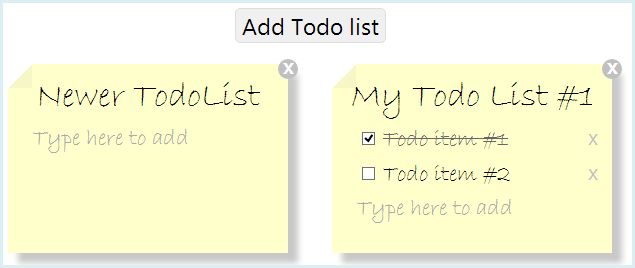
The post-authentication view is on top. It too is almost identical to the original in the ASP.NET SPA template. The only differences:

* A click binding to $root.clearErrorMessage on the TodoList and TodoItem *title* bindings.
* Rendering of the Breeze scripts bundle near the bottom of the file.

The ASP.NET SPA template documentation explains how Knockout (KO) binding declarations in this view correspond to properties and methods of the ViewModel (todo.viewmodel.js). We’ll briefly recap.

KO is a data binding library in MVVM (Model-View-ViewModel) style. You decorate HTML elements in the View with special KO binding attributes. Those attributes identify corresponding properties or methods in a JavaScript object called the ViewModel. When the user enters values or clicks a button, KO pushes values into the ViewModel properties or invokes methods. If the ViewModel properties are “observable”, KO can detect and push changes to those properties back into the View HTML.

The app presents one or more TodoLists in the guise of sticky notes.



[TwoTodoLists.png]

The outer markup for the TodoLists follows

<p class="error" data-bind="text: error"></p>

<button data-bind="click: addTodoList">Add Todo list</button>

<section id="lists" data-bind="foreach: todoLists, visible: todoLists().length > 0">

<article class="todoList"> ... </article>

</section>

The <p> element shows the most basic Knockout (KO) binding. The “**data-bind**” attribute is the KO binding. It binds the paragraph text to the contents of the ViewModel’s “error” property. The ViewModel, in this case, is an object created by the *todo.viewmodel.js* script which we’ll look at soon.

The click action of the <button> element is bound to the addTodoList method of the ViewModel. We hope you’re starting to get the picture.

#### Knockout repeaters and templates

The <section> element is bound with a KO repeater instruction. In plain English, it says

“Take each item from the ViewModel’s todoLists array property and bind it to the template defined in the <article> element.”

The “visible: ...” binding tells KO to reveal the repeater only if there is at least one TodoList.

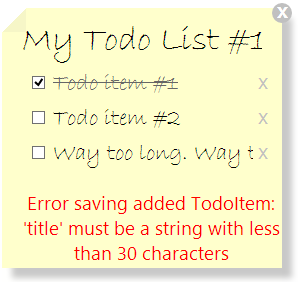
Rummage around in the <article> template and you’ll find another repeater.

<ul data-bind="foreach: todos">

<li>... </li>

</ul>

Now the TodoList is serving as the ViewModel. The TodoList has a todos property with zero or more TodoItems. This repeater creates an <li> element for each TodoItem and binds it to the template defined within the <li>. Here are three TodoItems bound to this template followed by the template itself:



<li>

<input type="checkbox" data-bind="checked: isDone" />

<input class="todoItemInput" type="text"

data-bind="value: title,

disable: isDone,

blurOnEnter: true,

click: $root.clearErrorMessage" />

<a href="#" data-bind="click: $parent.deleteTodo">X</a>

<p class="error" data-bind="visible: errorMessage, text: errorMessage"></p>

</li>

Some observations:

* The *disable* binding add the “disable” attribute to the <input> element when the TodoItem is done, thus preventing changes to its *title*.
* A CSS selector in *TodoList.css* adds the strikethrough and lightens the *title* text.
* KO updates a ViewModel property when the element loses focus.
* *blurOnEnter* listens for the Enter key; when heard, it forces “lost focus” which causes KO to update the *title* property. This is one of the custom KO bindings defined in *todo.bindings.js.*
* clicking in clears the error message … as we’ll explain in a moment
* The little “x” after the title is a link bound to the deleteToDo method. This method is not on the TodoItem but on its parent TodoList. We’ll be looking for that property when we examine the TodoList initializer in *todo.model.js*.
* A TodoItem has an errorMessage property which, if other than an empty string, will appear in a paragraph below the title as we see in the third example TodoItem.

This is the same HTML and the same bindings we’d see in an app generated from the ASP.NET SPA template … except for the click binding to $root.clearErrorMessage.

The “$root” token tells KO to look for a method at the root of the binding tree, the clearErrorMessage method of the ViewModel defined in *todo.viewmodel.js*. We added this feature to the Breeze sample so the user could clear away the error message while fixing the title; the persistence of the error message had been a usability annoyance.

### ViewModel

The *todo.viewmodel.js* file defines the app’s lone ViewModel. This ViewModel exposes five members for binding to the View. Examine the KO data bindings and you’ll see that they refer either to one of these five members or to a member of a Todo entity. This is the recommended strategy for your Knockout MVVM applications.

The five data bound members belong to the ViewModel object returned at the bottom of the module.

return {

todoLists: todoLists, // observable array of TodoList objects

error: error, // application error message

addTodoList: addTodoList, // creates and saves a new TodoList

deleteTodoList: deleteTodoList, // delete a TodoList and its child TodoItems

clearErrorMessage: clearErrorMessage // clear an object’s error message

};

This is a good example of the Revealing Module Pattern described by [Dan Wahlin in this PluralSight post](http://blog.pluralsight.com/2012/10/02/revealing-module-pattern-structuring-javascript-code-part-iii/).

The last line of the file binds the View to the ViewModel bringing application life to the screen.

ko.applyBindings(window.todoApp.todoListViewModel);

### ViewModel invariance

One of the design goals for the Breeze template was to show that **a properly designed View and ViewModel can be independent of the supporting data modeling and management layers**.

For this reason, the Breeze SPA template View and ViewModel are virtually identical to their counterparts in the ASP.NET SPA template. The only substantive difference was the necessary inclusion of Breeze library scripts in the **Index.cshtml**.

As a bonus we added the error message clearing feature. The extra clearErrorMessage method adds four lines to what would otherwise be an identical todo.viewmodel.js file. We could back-port this to the ASP.NET SPA template “as is”.

The two template applications have very different model and data access implementations. Their ViewModels can be identical because they stick to their responsibility: **support the View**. They delegate their model and data access differences to a separate datacontext component.

### DataContext

The *todo.datacontext.js* file defines a *datacontext* module object that handles all remote data access.

var datacontext = {

metadataStore: manager.metadataStore,

getTodoLists: getTodoLists,

createTodoList: createTodoList,

createTodoItem: createTodoItem,

saveNewTodoItem: saveNewTodoItem,

saveNewTodoList: saveNewTodoList,

deleteTodoItem: deleteTodoItem,

deleteTodoList: deleteTodoList

};

The method names give a clear indication of their purpose. Their implementations deserve some attention.

### Configuring for Breeze

We meet Breeze for the first time in *todo.datacontext.js*. The first step is to configure Breeze for the application. This application uses the Web API and Knockout. Those are Breeze defaults so we don’t have to tell Breeze about them.

By default, Breeze would use the same spelling for property names on both client and server. We want to follow the JavaScript standard of camel case property names (e.g., “todoListId”). The corresponding CLR class names on the server are in Pascal case (e.g., “TodoListId”). We tell Breeze to use the camel case naming convention instead of its default.

breeze.NamingConvention.camelCase.setAsDefault();

Breeze will translate the names accordingly as it makes requests and receives responses from the server.

### Create an EntityManager

We’ll need a Breeze [EntityManager](http://www.breezejs.com/documentation/entitymanager-and-caching) to handle communications with the server and to hold the cache of entities that we query, create, and save. We create one, specifying the endpoint of our Web API controller (discussed below) as the constructor parameter.

var manager = new breeze.EntityManager("api/Todo");

The datacontext holds on to this manager for the duration of the user session. Every entity we create, modify, query and save resides in this manager’s entity cache.

Let’s skip over the next two lines of manager configuration. We’ll get to them later when we talk about saving changes.

### Querying with Breeze

This application loads all of its Todo data when the application launches and never asks for data again. That’s not very realistic but it does dampen the complexity for the ASP.NET SPA template. Let’s see how Breeze does it. Here’s the signature of the getTodoLists method:

function getTodoLists(todoListsObservable, errorObservable)

The ViewModel calls this method with an empty observable array for TodoLists – to be filled if they are retrieved successfully – and an observable object to hold an error message if the request for data fails. Both observables are bound to the view in Index.cshtml.

Here’s the implementation:

return breeze.EntityQuery

.from("TodoLists") // query the "TodoLists" resource

.expand("Todos") // include TodoItems in the response payload

.orderBy("todoListId desc") // sort the TodoLists by Id on the data tier

.using(manager).execute() // execute the query using the manager

.then(getSucceeded) // call getSucceeded if the query succeeds

.fail(getFailed); // else call getFailed

The resemblance to LINQ is intentional. Breeze uses method chaining to build up a query object. We’re barely tapping the range of possibilities in this sample. Checkout the [query examples in the breeze documentation](http://www.breezejs.com/documentation/query-examples).

Having defined the query, we execute it. The execute() method is asynchronous. Like all Breeze asynchronous methods it returns a promise – a promise to tell the client what the server said when it responded to the request. The flow of control continues until the server responds. If query succeeded, the promise calls

function getSucceeded(data) {

todoListsObservable(data.results);

}

The query returns a data object whose members describe various aspects of the response. The most important member is the array of results which we pour into the ViewModel’s observable array.

#### Query results

The data arrived from the server as JSON. Breeze converted the JSON data to Breeze TodoList entities. These are Knockout observable objects, ready for KO data binding. Each TodoList is held in the manager’s cache where it will be watched for changes. Each TodoList has a navigation property (todos) that returns an observable collection of its child TodoItems. These TodoItems were extracted from the query response payload and attached to the manager’s cache.

### Creating new Todo data

This application creates new Todo model objects in 3 steps:

1. Create a new entity
2. Set its initial values
3. Save it

Creation of a new TodoList in the ViewModel is one place to see this pattern:

addTodoList = function () {

var todoList = datacontext.createTodoList();

todoList.isEditingListTitle(true);

datacontext.saveNewTodoList(todoList)

.then(addSucceeded)

.fail(addFailed);

}

Notice the two calls to the datacontext: once to create the TodoList, the second to save it. Here are those methods:

function createTodoList() {

return manager.createEntity("TodoList");

}

function saveNewTodoList(todoList) {

return saveEntity(todoList);

}

You generally don’t “*new up*” an entity in Breeze. Instead you call the EntityManager.createEntity factory as we did here.

We’ll look inside the datacontext’s saveEntity method in a moment. From the outside we see that it returns a promise. A save is an asynchronous operation. Eventually it either succeeds or fails and we invoke the addSucceeded or addFailed accordingly.

### Save Changes

Were you to review the datacontext of the ASP.NET SPA, you’d see separate save operations for each kind of entity change: add, modify, and delete. You might also notice that only saves one instance of one type of entity at a time.

That’s ok for this simple Todo example which saves after every change of any kind. That’s not how most applications work. They aren’t that chatty.

In a “real Todo app”, you might create a new TodoList, add several TodoItems to it, and then save all of your changes at once in a single batch. Or you might delete one TodoItem, mark another one done, and add a new Todo before clicking a save button and saving these diverse changes as a batch.

The ASP.NET SPA would have been much more complicated if it had to meet these requirements. Breeze, on the other hand, is designed for these scenarios.

Breeze accumulates changes in a manager’s cache. When you’re ready, you call EntityManager.saveChanges() and they all go together to the server as a single save request. In the Breeze SPA template app we had to bend the one-entity-at-a-time pattern to the Breeze way by routing each single-object-save through a common saveEntity method:

function saveEntity(masterEntity) {

return manager.saveChanges().fail(saveFailed);  
}

We don’t need the masterEntity to perform the save. We’re saving all entities in cache with pending changes. Most of the time in this app, there is only one unsaved entity in cache.

#### Save failure

Notice that the promise returned from the saveChanges call lacks a success callback. If the save succeeds, there’s nothing to do. But if the save fails, we want to analyze the failure and take steps to set things right.

function saveFailed(error) {

setErrorMessage(error);

// Let user see invalid value briefly before reverting"

setTimeout(function() { manager.rejectChanges(); }, 1000);

throw error; // so caller can see failure

}

Something bad happened. The safest recourse is to reverse all of the pending changes by calling manager.rejectChanges, and then invite the user to try again. We’ll give the user about one second to see both the error message and the errant entity values before rolling back the changes.

But first we have to extract a suitable message from the error. The View will display the message to the user and we want to compose a message that is helpful.

The message begins by identifying the entity we were trying to save. This is a general purpose save method so we have to rely on intrinsic features of every Breeze entity to determine the entity type (TodoItem or TodoList) and the nature of the change which is found in the EntityState.

A save could have failed for a variety of reasons. A validation error is a common cause.

### Breeze Validation

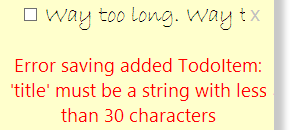
The CLR classes on the server impose certain restrictions on some of the entity properties. For example, the two Title properties are required and have maximum lengths.

Breeze captures and forwards these constraints as part of the metadata it sends to the client. BreezeJS turns these constraints into [**client-side validation rules**](http://www.breezejs.com/documentation/validation) and executes these rules at particular moments in the entity life-cycle. One of those moments is when you save changes.

Breeze runs the validation rules for every entity before saving it. If any entity fails a validation rule, Breeze terminates the entire save without contacting the server. The user doesn’t have to wait for the server to tell him he made a mistake.

Every entity maintains its own collection of validation errors. That collection is empty when the entity passes validation. It won’t be empty if the entity fails validation. The datacontext.getValidationErrorMessage method shows how to extract the validation error message from the validation error collection.

To see validation in action, enter an especially long name for a TodoItem. The screen should display something like this:



[TooLongValidationError.png]

### Configuring the manager for saves

We conclude the datacontext review by returning, as promised, to the two lines of manager configuration near the top of the file.

#### Save Queuing

A save is an asynchronous operation involving a communication with the server. We can’t tell if the save succeeded or failed until the server returns with a response. That could take a while.

If we try a second save while a previous save is in progress, Breeze might try to add or delete the same entity twice. Therefore, the Breeze manager refuses to save a second time while another save is “in flight”.

There is a problem. This application saves every time the user makes a change. There is no save button and no way to disable user changes while we’re waiting for a server response. The user could easily make another change, triggering another save before the first save completes. The manager will refuse and throw an error. We don’t want that.

Fortunately, there is a Breeze plugin, *breeze.savequeuing.js*, that can queue the second save while the first save is “in flight”. We enable it for this manager with this line:

manager.enableSaveQueuing(true);

#### Save on modify

This application saves immediately when the user adds, modifies or deletes a TodoList or a TodoItem. It takes a dedicated method to add or delete an object. Such methods are defined in this data context and it’s pretty easy to wire in a call to the manager’s save method as we’ll see.

But modifying an existing entity is a little different. We might change the title. We might check/uncheck the checkbox bound to its isDone property. Somehow we have to detect any change to the object and save it.

We could listen to the change event of the Knockout observable for every property of every object. That’s what the ASP.NET SPA template app does. This doesn’t seem so onerous when there are only three properties to worry about (TodoList.title, TodoItem.title, TodoItem.isDone). It would be madness to add thousands of event handlers to entities with the hundreds of properties typical of a real model.

We have a much easier alternative in Breeze. Breeze “entities” are self-tracking. Each entity maintains an [EntityState](http://www.breezejs.com/documentation/inside-entity) which is accessible through its entityAspect property. A change to any property of an unmodified entity flips its EntityState to “Modified”.

We can listen in exactly one place for the EntityState to flip on any entity. That place is the manager that holds the entity in its cache. Here’s how:

manager.entityChanged.subscribe(entityStateChanged);

The entityStateChanged handler suffices for every entity. All it must do is examine the entity to see if it flipped to “Modified” and, if so, save it.

The last step of manager configuration sets up this listener:

configureManagerToSaveModifiedItemImmediately();

## Model

The *todo.model.js* file defines the client-side Todo object model.

Open the file and discover something surprising. **The persistent properties of TodoItem and TodoList are not defined**!

In the ASP.NET SPA, we part of the TodoItem definition looked like this:

self.todoItemId = data.todoItemId;

self.title = ko.observable(data.title);

self.isDone = ko.observable(data.isDone);

self.todoListId = data.todoListId;

There is no such code in the Breeze SPA because Breeze generates entity type definitions from metadata. Moreover, Breeze understands that we’re using Knockout so it automatically generates entities with KO observable properties.

Where do metadata come from? Most Breeze applications get their metadata from the server. A Breeze client can get metadata from an OData data source. It can also get metadata from a suitable Web API controller such as a Breeze controller fronting an Entity Framework model. That’s how this Breeze SPA gets its metadata.

#### Extending entity definitions on the client

Metadata from the server can only describe properties of the classes exposed on the server. We often need to enrich a client-side model type with properties and behavior that exist only on the client.

Consider the errorMessage property. This SPA app expects every TodoItem and TodoList to have an errorMessage property. Usually that property returns an empty string. But if something goes wrong when saving the entity, the errorMessage will contain an explanation of the failure.

We never save the errorMessage to the database. The server-side TodoItem and TodoList don’t have this property. This property exists only on the client to support the user experience.

Breeze lets us extend the definition of the client entity types with custom members. We can do so in two ways: with a custom constructor or with an initializer. This sample illustrates both techniques.

var store = datacontext.metadataStore;

store.registerEntityTypeCtor("TodoItem", null, todoItemInitializer);

store.registerEntityTypeCtor("TodoList", TodoList, todoListInitializer);

The first parameter identifies the entity type. The second is the custom constructor. The third is the initializer.

The Breeze [documentation explains constructors and initializers](http://www.breezejs.com/documentation/extending-entities) in detail but you can get the gist of it by looking at the *todo.model.js* file. You’ll see the errorMessage property added by initializers. You’ll see a TodoList constructor that defines default values for new TodoLists and carries prototype methods for adding and deleting child TodoItems.

This wraps up our tour of the client code. Let’s move to the server.

# The Server

The web application project structure should be familiar to anyone acquainted with MVC 4 projects. In this section we’ll highlight a few of the server-side files that are specific to the Breeze version of the SPA template application.

## App\_Start/BreezeWebApiConfig

The *App\_Start* folder holds web application configuration detail classes. The Breeze SPA template added the *BreezeWebApiConfig* file to **define a Breeze Web API route** and **position it in front** of the default Web API routes. Here’s the route:

GlobalConfiguration.Configuration.Routes.MapHttpRoute(

name: "BreezeApi",

routeTemplate: "api/{controller}/{action}"

);

The typical Breeze application sends data requests to a single Web API controller. The URL identifies the controller and an action to perform. Here’s a request for all TodoLists:

http://localhost:60124/api/Todo/TodoLists

We’ll look at this again soon when we examine the controller. For now we observe that the “Todo” path segment maps to the {controller} token and “TodoLists” to the {action} token.

This routing scheme differs from the default Web API route defined in WebApiConfig. Rather than modify that file we added BreezeWebApiConfig and gave its route precedence via the WebActivator assembly attribute at the top of the file:

[assembly: WebActivator.PreApplicationStartMethod(...)

## App\_Start/BundleConfig

This application uses [Web Optimization](http://www.asp.net/mvc/tutorials/mvc-4/bundling-and-minification) to bundle and minify files delivered to the browser. We’re using Breeze so we’ve added a bundle of Breeze-related scripts:

bundles.Add(new ScriptBundle("~/bundles/breeze").Include(

"~/Scripts/q.js",

"~/Scripts/breeze.debug.js",

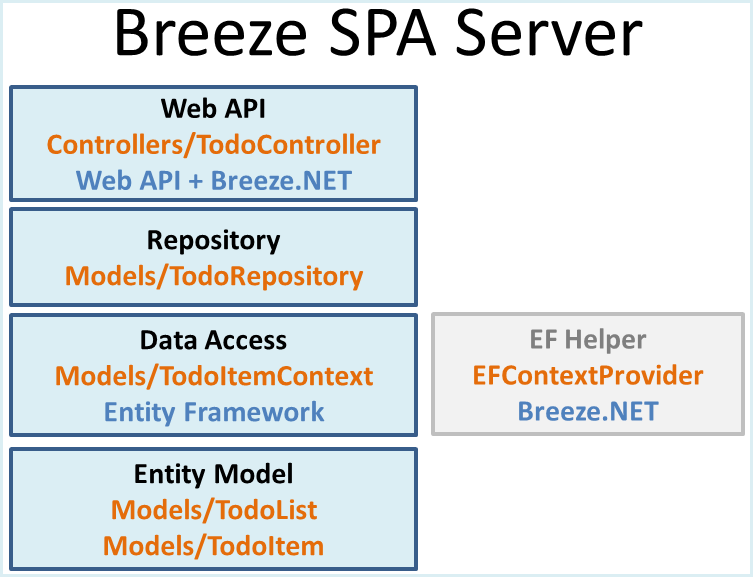
"~/Scripts/breeze.min.js",

"~/Scripts/breeze.savequeuing.js"));

* [q.js](https://github.com/kriskowal/q#readme) – a promises library to simplify asynchronous programming
* [breeze.debug.js](http://www.breezejs.com/documentation/download) – the un-minified breeze library
* [breeze.min.js](http://www.breezejs.com/documentation/download) – the minified breeze library. Web Optimization will only bundle one or the other of the Breeze libraries depending upon whether you build the application for debug or release.
* [breeze.savequeuing.js](http://www.breezejs.com/documentation/download) – a Breeze plugin to handle concurrent client save requests.

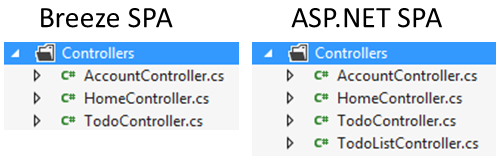
## Controllers

With those application start files squared away, we’re ready to look at the important elements of the server-side stack. The following diagram will be our guide as we work back from the client-facing Web API to the entity model.



[ServerArchitecture.png]

By convention, the *Controllers* folder holds both MVC and Web API controllers.



The two MVC controllers, *HomeController* and *AccountController*, are the same in both templates. The *HomeController* serves the SPA host page; the *AccountController* handles authentication-related requests (registration, login, logout, etc.).

The ASP.NET SPA app follows the “controller-per-model-type” resource-oriented approach. This has a two-entity model so the ASP.NET SPA has two controllers. A Breeze app follows the action-oriented approach and typically only needs Web API controller to cover requests for the entire model.

It only needs one Web API controller because the number of requests it must handle is comparatively few.

## TodoController

The TodoController exposes only three methods:

|  |  |
| --- | --- |
| **Metadata** | Get metadata about the server model |
| **SaveChanges** | Save a bundle of entity changes |
| **TodoLists** | Get “Todolist” data, potentially filtered, ordered, paged, and extended with child Todos |

#### Metadata and SaveChanges

The first two are standard fare. A Breeze client needs metadata describing the model. Most Breeze developers prefer to get metadata from the server and this controller can supply the metadata.

The ASP.NET SPA uses jQuery AJAX calls to save each change one item at a time. Look at one of its controllers and you’ll see PUT, POST, and DELETE methods to update, add, and delete single items.

A Breeze app saves multiple changes as a bundle in a single transaction. We could create a new TodoList, add new TodoItems, modify another TodoList, and delete a third (along with its child Todos). We could POST all of these changes one change-set to this controller’s SaveChanges method. This particular sample isn’t written to do that … it would have required a much more complicated ASP.NET SPA sample. The Breeze version might have been less complicated if we had.

#### Query methods

The ASP.NET sample has a single GET method, TodoListController.GetTodoLists. The Breeze version has a single GET method, TodoController.Todos. Both return TodoLists with their associated child TodoItems.

Here’s the ASP.NET SPA original:

public IEnumerable<TodoListDto> GetTodoLists() {

return db.TodoLists.Include("Todos")

.Where(u => u.UserId == User.Identity.Name)

.OrderByDescending(u => u.TodoListId)

.AsEnumerable()

.Select(todoList => new TodoListDto(todoList));

}

It filters for the current user’s TodoLists. Then it sorts by the key in descending order. Then it casts to Enumerable so it can pass data to a DTO class which fetches the related child TodoItems.

The Breeze TodoController.Todos is much simpler:

[HttpGet]

public IQueryable<TodoList> TodoLists() {

return \_repository.TodoLists;

}

Sure it delegates to a repository – that’s where we moved the filter for the current user’s TodoLists. We’ll get to the repository shortly. The key point is that it returns an IQueryable, leaving the matter of sort order and inclusion of child TodoItems to the client’s discretion.

The client can filter, page, order, expand, and select a subset of TodoList properties by sending OData queries to this action:

http://localhost:60124/api/todo/todolists?$filter=TodoListId eq 1

http://localhost:60124/api/todo/todolists?$orderby=Title

http://localhost:60124/api/Todo/TodoLists?$orderby=Title&$skip=1&$top=1

http://localhost:60124/api/Todo/TodoLists?$expand=Todos

The client may be able to satisfy all of its data retrieval requirements by this single query method alone, thus maintaining a lean controller. When a single IQueryable method won’t suffice, you can add specialized GET actions to the controller and call them from the Breeze client.

It follows that the controller grows slowly, as slowly as one query method per exposed model type. For example, if the client needed TodoItems, independent of their parent TodoLists, we could add a fourth “*TodoItems*” query action method similar to the TodoLists method.

Aside from granting the client more flexibility for free, this approach also performs much better. The client-specified filtering, ordering, paging, and expand will execute on the data tier, not on the server tier.

The original ASP.NET SPA query casts to IEnumerable which means the server will fetch every one of the user’s TodoLists even if the client queried for only one of them. Worse, the DTO makes a second trip to the database to get the child TodoItems for each and every TodoList.

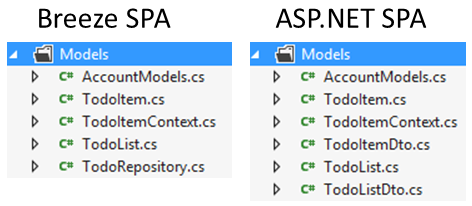
Of course you’ll never notice in this application which doesn’t do any serious querying. Upon launch it asks for all TodoLists belonging to the current user and that’s the last time it asks for any data. We’ll have to imagine how the controllers will be affected by richer client requirements.

#### TodoController attributes

The Breeze controller is decorated with two attributes

|  |  |
| --- | --- |
| **Authorize** | The Web API attribute that prevents unauthenticated users from reaching the controller. |
| **BreezeController** | Configures this controller to talk to Breeze clients. It replaces all filters with a [Newtonsoft Json.NET](http://james.newtonking.com/pages/json-net.aspx) filter configured for Breeze that serializes and deserialized data as JSON. It also installs the Breeze Action filter that interprets OData query parameters and applies them to the IQueryable objects returned by such GET action methods as TodoLists; it replaces a similar Web API filter for this controller only. |

## Models



The SPA sample apps rely on Entity Framework (EF) Code First models. The model entity classes and the TodoItemContext (a DbContext) are almost identical in the two templates. The only entity class changes: we added **MaxLength** attributes to the **Title** properties so we could demonstrate Breeze validation. Breeze includes the maximum string length and required constraints in the metadata it sends to the client. We get these validations for free in Breeze. The user learns about validation errors immediately, without a delayed rejection from the server. Of course EF will also apply these validations on the server automatically; that’s a feature of EF’s DbContext.

The Breeze model omits the DTO classes which are neither needed nor wanted. The shapes of the TodoItem and TodoList types are the same on client and server so there is no reason to complicate the model with DTO classes.

The Breeze model adds a TodoRepository to encapsulate business logic governing client access to model data.

## Models/TodoRepository

The TodoRepository mediates between the Web API controller and the Entity Framework which provides access to the database (as it does for the ASP.NET SPA app).

We could have written the business logic inside the controller. Instead, the three client-facing methods of the TodoController delegate to an instance of this TodoRepository class. We’re conforming to a general principle of Web API controller design which argues for simple implementations. The controller is supposed to direct traffic, not do heavy work of its own.

The TodoRepository inherits from a Breeze.NET helper class, the EFContextProvider, which vastly simplifies interactions with the Entity Framework. You can read about it [here](http://www.breezejs.com/documentation/custom-efcontextprovider).

The repository is a good place to start putting server-side business logic. A typical demo wouldn’t have business logic which is why many samples simply delegate directly to the EFContextProvider.SaveChanges method. This SPA sample actually has some business logic. Let’s take a peek.

#### Query constraints

Here is the TodoLists query to which the TodoController delegates its own TodoLists GET method:

public DbQuery<TodoList> TodoLists {

get {

return (DbQuery<TodoList>)Context.TodoLists

.Where(t => t.UserId == UserId);

}

}

Context is a typical Entity Framework DbContext object sporting named DbQuery properties. In this app a user may only see her own TodoLists; we’re enforcing that rule in the repository rather than in the controller.

#### Save constraints

The server shouldn’t trust the client. That’s especially important with save requests. You should validate client data for data integrity and authorization before storing them to the database.

The JSON payload of a Breeze save request is deserialized by [Newtonsoft Json.NET](http://james.newtonking.com/pages/json-net.aspx) into a “bundle” object representing an entity change-set. The EFContextProvider.SaveChanges method (a) dissects the bundle, (b) prepares the Entity Framework (EF) Context for the save, and (c) calls Context.SaveChanges on your behalf.

Between (a) and (b) it gives you two chances to intervene. You can intercept each entity before the provider adds it to the Context by overriding BeforeSaveEntity. In your override you can approve the entity (return true), exclude the entity silently (return false), or throw an exception that terminates the entire save.

You don’t want too much logic in the repository so, in a bigger app, you probably would treat this override as a dispatcher to type-specific validation classes. But this is a small sample so we validate the TodoItem and TodoList entities right here in the repository.

We validate a TodoList as follows:

private bool BeforeSaveTodoList(TodoList todoList, EntityInfo info)

{

if (info.EntityState == EntityState.Added)

{

todoList.UserId = UserId;

return true;

}

return UserId == todoList.UserId || throwCannotSaveEntityForThisUser();

}

If the TodoList is new, we assign it to the current user. Otherwise (modify and delete), we confirm that the TodoList belongs to the current user and throw an exception it if isn’t. We’re imposing the same logic you’ll find in the PUT, POST, and DELETE methods of the ASP.NET SPA sample’s TodoListController. Compare for yourself.

Your second opportunity to intervene is the BeforeSaveEntities virtual method which gives you a chance to inspect the entire change-set as a whole. We don’t use that feature in this sample.

## What is Breeze.NET?

You thought Breeze was a JavaScript library. Yet we’re still on the server describing Breeze components such as the EFContextProvider.

BreezeJS is a pure JavaScript technology. You do not need any Breeze on the server. The server need not use use any Microsoft technology: not IIS, not Web API, not Entity Framework, not SQL server.

But this SPA sample is generated from an ASP.NET MVC template. That means .NET on the backend. We’ve made it easier to program a .NET backend with Breeze.NET components in support of the BreezeJS pure JavaScript technology on the client. A casual comparison with the hand-rolled save logic in the ASP.NET SPA sample reveals just how helpful Breeze.NET can be.