Aura Open Source Developer Guide

Last updated: April 20, 2018

CONTENTS

CHAPTER 1 What is Aura?

In this chapter ...

Aura is a UI framework for developing dynamic web apps for mobile and desktop devices. It's a modern framework for building single-page applications engineered for growth.

The framework supports partitioned multi-tier component development that bridges the client and server. It uses JavaScript on the client side and Java on the server side.

Why Use Aura?

The benefits include an out-of-the-box set of components, event-driven architecture, and a framework optimized for performance.

Out-of-the-Box Component Set
: Comes with an out-of-the-box set of components to kick start building apps. You don't have to spend your time optimizing your apps for different devices as the components take care of that for you.

Performance
: Uses a stateful client and stateless server architecture that relies on JavaScript on the client side to manage UI component metadata and application data. The client calls the server only when absolutely necessary; for example to get more metadata or data. The server only sends data that is needed by the user to maximize efficiency. The framework uses JSON to exchange data between the server and the client. It intelligently utilizes your server, browser, devices, and network so you can focus on the logic and interactions of your apps.

Event-driven architecture
: Uses an event-driven architecture for better decoupling between components. Any component can subscribe to an application event, or to a component event they can see.

Faster development
: Empowers teams to work faster with out-of-the-box components that function seamlessly with desktop and mobile devices. Building an app with components facilitates parallel design, improving overall development efficiency. Aura provides the basic constructs of inheritance, polymorphism, and encapsulation from object-oriented programming and applies them to presentation layer development. The framework enables you to extend a component or implement a component interface.

  Components are encapsulated and their internals stay private, while their public shape is visible to consumers of the component. This strong separation gives component authors freedom to change the internal implementation details and insulates component consumers from those changes.

Device-aware and cross browser compatibility
: Apps use responsive design and provide an enjoyable user experience. Aura supports the latest in browser technology such as HTML5, CSS3, and touch events.

Components

Components are the self-contained and reusable units of an app. They represent a reusable section of the UI, and can range in granularity from a single line of text to an entire app.

The framework includes a set of prebuilt components. You can assemble and configure components to form new components in an app. Components are rendered to produce HTML DOM elements within the browser.

A component can contain other components, as well as HTML, CSS, JavaScript, or any other Web-enabled code. This enables you to build apps with sophisticated UIs.

The details of a component's implementation are encapsulated. This allows the consumer of a component to focus on building their app, while the component author can innovate and make changes without breaking consumers. You configure components by setting the named attributes that they expose in their definition. Components interact with their environment by listening to or publishing events.

SEE ALSO:

Creating Components

Component Reference

Events

Event-driven programming is used in many languages and frameworks, such as JavaScript and Java Swing. The idea is that you write handlers that respond to interface events as they occur.

A component registers that it may fire an event in its markup. Events are fired from JavaScript controller actions that are typically triggered by a user interacting with the user interface.

There are two types of events in the framework:

- **Component events** are handled by the component itself or a component that instantiates or contains the component.
- **Application events** are handled by all components that are listening to the event. These events are essentially a traditional publish-subscribe model.

You write the handlers in JavaScript controller actions.

SEE ALSO:

Communicating with Events

Handling Events with Client-Side Controllers

Aura Version Numbers

Aura uses version numbers that are consistent with other Maven projects. This makes it easy for projects built with Maven to express their dependency on Aura.

The version number scheme is:

`major.minor``[`**`.incremental`**`][-`**`qualifier`**`]`

The `major`, `minor`, and optional `incremental` parts are all numeric. The `qualifier` string is optional. For example, `1.2.0`, `2.4`, or `2.5.0-SNAPSHOT` are all valid.

The `major` number advances and the `minor` and `incremental` counters reset to zero for releases with large functional changes. Within a major release, the `minor` number advances for small updates with enhancements and bug fixes. The `incremental` counter is only used for targeted fixes, usually for critical bugs.

The `qualifier` string is largely arbitrary. A version number that includes a `qualifier` is a non-release build. The compatibility guarantee is weaker, because the build is stabilizing towards a release. In order of increasing stability, the qualifier may be:

`SNAPSHOT`
: An arbitrary development build. There are no assurances for such a build, as its under active development.

`msN`
: A milestone build. Some features can at least be demonstrated, but the build isn't ready for a full release. Feature behavior may change as the milestone progresses towards a release.

`rcN`
: A release candidate, which is a build we think is close to a final release. However, it's still undergoing final checking and may change before an unqualified release.

A release build has a fixed `major`, `minor`, and `incremental` version. It's newer and preferable to any unqualified version with the same version number. For example, `x.y.z` is newer than `x.y.z-SNAPSHOT`.

Release candidates are always newer than any milestone, and a release candidate or milestone with a higher number is newer than others with lower numbers.

If you have the source code for the Aura framework, you can find the version number in the root folder's `pom.xml` file. For example:

```
<project ... >
    <name>Aura Framework</name>
    <version>0.273</version>
</project>
```

Although it will rarely be important, you can use the Java `ConfigAdapter.getAuraVersion()` method to see what version of Aura is running your code.

CHAPTER 2 Quick Start

In this chapter ...

The quick start steps you through building and running your first Aura app from the command line, or in the Eclipse IDE. Choose the method you're most comfortable with and check out the next steps after you build an app.

Create an Aura App from the Command Line

You can generate a basic Aura app quickly using the command line. For details, see the `README.md` file in the Aura repo.

SEE ALSO:

Import an Aura App into Eclipse

Next Steps

Import an Aura App into Eclipse

This section shows you how to import the Aura app you created in the command-line quick start into Eclipse.

Note: You must complete the command-line quick start before proceeding.

Before you begin, make sure you have this software installed:

1. JDK 1.8
2. Apache Maven 3
3. Eclipse 3.7 or later and the m2eclipse plugin. Choose the Eclipse distribution for Java EE Developers. This includes JavaScript editing and other Web UI tools.

Step 1: Import the Command-Line Project into Eclipse

1. Click **File** > **Import...** > **Maven** > **Existing Maven Projects**.
2. Click **Next**.
3. In the **Root Directory** field, browse to the `helloWorld` folder created in the command-line quick start and click **OK**.
4. Click **Finish**.

You should now have a new project called `helloWorld` in the Package Explorer.

Step 2: Build and Run Your Project

1. Click **Run** > **Debug Configurations...**.
2. Double click **Maven Build**.
3. Enter these values:
   - **Name**: HelloWorld Server
   - **Base directory**: `${workspace_loc:/helloWorld}` (where `helloWorld` is the same as your Artifact Id)
   - **Goals**: `jetty:run`

   Note: To use another port, such as port 8080, append `-Djetty.port=8080` to `jetty:run`.

4. Click **Debug**.

You should see a message in the Eclipse Console window indicating that the Jetty server has started.

Step 3: Test Your App

1. Navigate to `http://localhost:8080` to test your app.

   You will be redirected to `http://localhost:8080/helloWorld/helloWorld.app`.

2. Validate that your app is working by looking for "hello web" in the browser page.

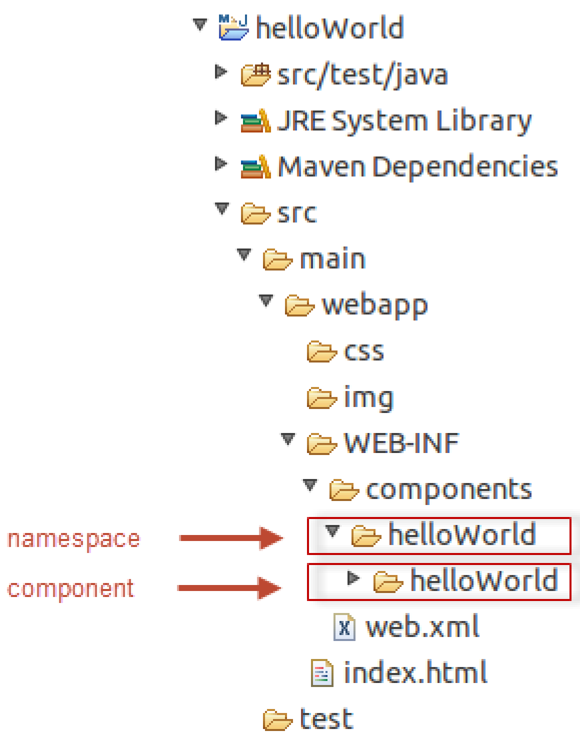
Add a Component

An Aura app is represented by a .app file composed of Aura components and HTML tags.

Components are the building blocks in your app and are grouped in a namespace. In addition to the required top-level <aura:component> tag in a component or <aura:application> tag in an application, you can insert user interface components using tags defined in the Aura component library.

In Eclipse, we'll add a component to our simple app. The following diagram shows the folder structure for the project. Under the components folder, there is a helloWorld folder representing the namespace. Under that folder is a sub-folder, also called helloWorld, which represents the application, which is a special type of component. This folder can also contain resources, such as CSS and JavaScript files. We will add a new component to the helloWorld namespace.

Note: Component and app names must be unique in the namespace and they don't have to match the namespace name.



Step 1: Make a New Component

1. In Eclipse Package Explorer, right-click the helloWorld namespace folder under components and select **New** > **File**.
2. Create a new hello component in the namespace by entering these values:

   Parent folder: helloWorld/src/main/webapp/WEB-INF/components/helloWorld/hello

   File name: hello.cmp

   Note: We're adding the component to a new hello folder under the helloWorld namespace folder.

3. Click **Finish**.

4. Open `hello.cmp` and enter:

```
<aura:component>
    Hello, world!
</aura:component>
```

5. Save the file.
6. View the component in a browser by navigating to `http://localhost:8080/helloWorld/hello.cmp`. If the component is not displayed, make sure that the web server is running.

Step 2: Add the Component to the App

Now, we're going to add our new component to the app. In this case, the component is simple, but the intent is to demonstrate how you can create a component that is reusable in multiple apps.

1. Open `helloWorld.app` and replace its contents with:

```
<aura:application>

    <h1>My First Aura App</h1>
        <helloWorld:hello />

</aura:application>
```

2. Save the file.
3. View the app in a browser by navigating to `http://localhost:8080/helloWorld/helloWorld.app`.

You created an app and added a simple component using Eclipse. Aura enables you to use JavaScript on the client and Java on the server to create rich applications, as you'll see in later topics.

SEE ALSO:

aura:application

Component Body

Next Steps

Now that you've created your first app, you might be wondering where do I go from here? There is much more to learn about Aura. Here are a few ideas for next steps.

- Look at the Aura source code and build it from source in Eclipse
- Browse components that come out-of-the-box with Aura.

Build Aura from Source

You don't have to build Aura from source to use it. However, if you want to customize the source code or submit a pull request with enhancements to the framework, here's how to do it. Before you begin, make sure you have this software installed:

1. JDK 1.8
2. Apache Maven 3

Step 1: Install git

The Aura source code is available on GitHub. To download the source code, you need an account on GitHub and the `git` command-line tool.

1. Create a GitHub account at https://github.com/signup/free.
2. Follow the instructions at https://help.github.com/articles/set-up-git to install and configure `git` and `ssh` keys.

You don't have to create your own repository. You'll be cloning the Aura source next.

Step 2: Get and Build Aura Source

1. On the command line, navigate to the directory where you want to keep the Aura source code.
2. Run the following commands to clone the source with `git` and build it with Maven:

```
git clone git@github.com:forcedotcom/aura.git
cd aura
mvn install
```

You should see a message that the build completed successfully.

Step 3: Import Aura Source into Eclipse

You can use your IDE of choice. These instructions show you how to import the Aura source into Eclipse.

1. Install Eclipse 3.7 or later and the m2eclipse plugin. Choose the Eclipse distribution for Java EE Developers. This includes JavaScript editing and other Web UI tools..
2. Import the Aura source by clicking **File** > **Import** > **Maven** > **Existing Maven Projects**.
3. Click **Next**.
4. In the **Root Directory** field, browse to the directory that you cloned.
5. Click **Next**.
6. Click **Finish**.

You should see the source in the Package Explorer.

Step 4: Run Aura from Eclipse

To run Aura's Jetty server from Eclipse:

1. Click **Window** > **Preferences** > **Maven** > **Installations** > **Add...**
2. Navigate to your Maven installation and select it.
3. Click **Run** > **Debug Configurations...**
4. Right click **Maven Build** and select **New**.
5. Enter `Aura Jetty` in the **Name** field.
6. In the **Base directory** field, click **Browse Workspace...**
7. Select `aura-jetty` and click **OK**.

   Note: Running `aura-jetty` enables you to test the doc app and run tests against it. You can't build custom apps using this method.

8. Enter `jetty:run` in the **Goals** field.
9. Click **Apply**.
10. Click **Debug**.

In the Console window, you should see a message that the Jetty server started. In a browser, navigate to `http://localhost:9090/` to access the server.

SEE ALSO:

Reference Doc App

CHAPTER 3 Creating Components

In this chapter ...

Components are the functional units of Aura.

A component encapsulates a modular and potentially reusable section of UI, and can range in granularity from a single line of text to an entire application.

Component Markup

Component files contain markup and have a `.cmp` suffix. The markup can contain text or references to other components, and also declares metadata about the component.

Let's start with a simple "Hello, world!" example in a `helloWorld.cmp` component.

```
<aura:component>
    Hello, world!
</aura:component>
```

This is about as simple as a component can get. The "Hello, world!" text is wrapped in the `<aura:component>` tags, which appear at the beginning and end of every component definition.

Components can contain most HTML tags so you can use markup, such as `<div>` and `<span>`. HTML5 tags are also supported.

```
<aura:component>
    <div class="container">
        <!--Other HTML tags or components here-->
    </div>
</aura:component>
```

Note: Case sensitivity should be respected as your markup interacts with JavaScript, CSS, and Java.

Component Naming Rules

A component name must follow these naming rules:

- Must begin with a letter
- Must contain only alphanumeric or underscore characters
- Must be unique in the namespace
- Can't include whitespace
- Can't end with an underscore
- Can't contain two consecutive underscores

Support Level

Each component has a support level ranging from fully supported (`GA`) to new and experimental (`PROTO`). The support level is defined in the `support` system attribute in the `<aura:component>` tag. For more information, see the Reference tab.

SEE ALSO:

aura:component

Component Access Control

Create a Custom Renderer

Dynamically Creating Components

Component Namespace

Every component is part of a namespace, which is used to group related components together.

Another component or application can reference a component by adding `<myNamespace:myComponent>` in its markup. For example, the `helloWorld` component is in the `docsample` namespace. Another component can reference it by adding `<docsample:helloWorld />` in its markup.

Note where this component file is stored in the filesystem:
`aura-components/components/docsample/helloWorld/helloWorld.cmp`

All core components are in the `aura-components/components` directory. All folders within that directory map to a namespace.

Each folder within a namespace folder maps to a specific component and contains all the resources necessary for the component. We refer to this folder as the component's bundle.

In this case, the `helloWorld` bundle only contains a `helloWorld.cmp` file, which has the markup for this component. See Component Bundles for more information on files you can include in the bundle.

Namespaces in Code Samples

The code samples throughout this guide use the `c` namespace. This namespace has no special significance for open source usage. You can replace the `c` namespace with any other namespace that you prefer to use for development.

Salesforce developers build Lightning components that are based on the open source Aura framework. The `c` namespace is the default namespace if you haven't set a namespace prefix for your Salesforce organization. Using the `c` namespace in our code samples makes it easier for you to reuse the code in both open source Aura components and Lightning components.

Viewing Components

How do we view a component in a Web browser?

In `DEV` mode, you can address any component using the URL scheme
`http://<myServer>/<namespace>/<component>.cmp`

1. Start the Jetty server on port 8080.

   ```
   mvn jetty:run
   ```

   To use another port, append `-Djetty.port=portNumber`. For example:

   ```
   mvn jetty:run -Djetty.port=9877
   ```

2. Create a component in `aura-components/components/docsample/helloWorld/helloWorld.cmp`. Add this markup to the component.

   ```
   <!--docsample:helloWorld-->
   <aura:component>
       Hello, world!
   </aura:component>
   ```

3. View your component in a browser by navigating to:

   `http://localhost:8080/helloWorld/helloWorld.cmp`

   You should see a simple greeting in your browser.

4. To stop the Jetty server and free up the port when you are finished, press `CTRL+C` on the command line.

Component Bundles

A component bundle contains a component or an app and all its related files.

File	File Name	Usage	See Also
Component or Application	`sample.cmp` or `sample.app`	The only required resource in a bundle. Contains markup for the component or app. Each bundle contains only one component or app resource.	Creating Components on page 11 aura:application on page 314
CSS Styles	`sample.css`	Contains styles for the component.	CSS in Components on page 18
Controller	`sampleController.js`	Contains client-side controller methods to handle events in the component.	Handling Events with Client-Side Controllers on page 110
Documentation	`sample.auradoc`	A description, sample code, and one or multiple references to example components	Providing Component Documentation on page 70
Model	`sampleModel.js`	JSON model to initialize a component.	JSON Models on page 215
Renderer	`sampleRenderer.js`	Client-side renderer to override default rendering for a component.	Create a Custom Renderer on page 182
Helper	`sampleHelper.js`	Helper methods that are shared by the controller and renderer.	Sharing JavaScript Code in a Component Bundle on page 167
Provider	`sampleProvider.js`	Client-side provider that returns the concrete component to use at runtime.	Client-Side Runtime Binding of Components on page 186
Test Cases	`sampleTest.js`	Contains a test suite to be run in the browser.	Testing and Debugging Components on page 241

All resources in the component bundle follow the naming convention and are auto-wired. For example, a controller `<componentName>Controller.js` is auto-wired to its component, which means that you can use the controller within the scope of that component.

Component IDs

A component has two types of IDs: a local ID and a global ID. You can retrieve a component using its local ID in your JavaScript code. A global ID can be useful to differentiate between multiple instances of a component or for debugging purposes.

Local IDs

A local ID is an ID that is only scoped to the component. A local ID is often unique but it's not required to be unique.

Create a local ID by using the `aura:id` attribute. For example:

```
<lightning:button aura:id="button1" label="button1"/>
```

Note: `aura:id` doesn't support expressions. You can only assign literal string values to `aura:id`.

Find the button component by calling `cmp.find("button1")` in your client-side controller, where `cmp` is a reference to the component containing the button.

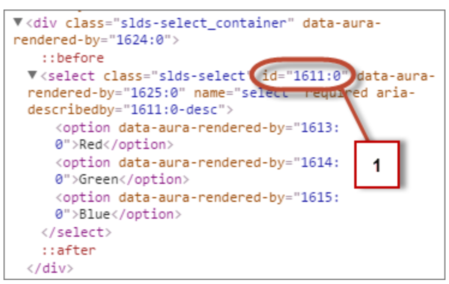
`find()` returns different types depending on the result.

- If the local ID is unique, `find()` returns the component.
- If there are multiple components with the same local ID, `find()` returns an array of the components.
- If there is no matching local ID, `find()` returns `undefined`.

To find the local ID for a component in JavaScript, use `cmp.getLocalId()`.

Global IDs

Every component has a unique `globalId`, which is the generated runtime-unique ID of the component instance. A global ID (1) is not guaranteed to be the same beyond the lifetime of a component, so it should never be relied on. A global ID can be useful to differentiate between multiple instances of a component or for debugging purposes.



To create a unique ID for an HTML element, you can use the `globalId` as a prefix or suffix for your element. For example:

```
<div id="{!globalId + '_footer'}"></div>
```

In your browser's developer console, retrieve the element using `document.getElementById("<globalId>_footer")`, where `<globalId>` is the generated runtime-unique ID.

To retrieve a component's global ID in JavaScript, use the `getGlobalId()` function.

```
var globalId = cmp.getGlobalId();
```

SEE ALSO:

Finding Components by ID
Which Button Was Pressed?

HTML in Components

An HTML tag is treated as a first-class component by the framework. Each HTML tag is translated into an `<aura:html>` component, allowing it to enjoy the same rights and privileges as any other component.

For example, the framework automatically converts a standard HTML `<div>` tag to this component:

```
<aura:html tag="div" />
```

You can add HTML markup in components. Note that you must use strict XHTML. For example, use `<br/>` instead of `<br>`. You can also use HTML attributes and DOM events, such as `onclick`.

Warning: Some tags, like `<applet>` and `<font>`, aren't supported.

Unescaping HTML

To output pre-formatted HTML, use `aura:unescapedHTML`. For example, this is useful if you want to display HTML that is generated on the server and add it to the DOM. You must escape any HTML if necessary or your app might be exposed to security vulnerabilities.

You can pass in values from an expression, such as in `<aura:unescapedHtml value="{!v.note.body}"/>`.

`{!`***`expression`***`}` is the framework's expression syntax. For more information, see Using Expressions on page 43.

IN THIS SECTION:

Supported HTML Tags
The framework supports most HTML tags, including the majority of HTML5 tags.

SEE ALSO:

Supported HTML Tags
CSS in Components

Supported HTML Tags

The framework supports most HTML tags, including the majority of HTML5 tags.

We recommend that you use components in preference to HTML tags. For example, use `ui:button` instead of `<button>`.

Components are designed with accessibility in mind so users with disabilities or those who use assistive technologies can also use your app. When you start building more complex components, the reusable out-of-the-box components can simplify your job by handling some of the plumbing that you would otherwise have to create yourself. Also, these components are secure and optimized for performance.

Note that you must use strict XHTML. For example, use `<br/>` instead of `<br>`.

Some HTML tags are unsafe or unnecessary. The framework doesn't support these tags.

The `HtmlTag` enum in this open-source Aura file lists the supported HTML tags. Any tag followed by `(false)` is not supported. For example, `applet(false)` means the `applet` tag isn't supported.

IN THIS SECTION:

Anchor Tag: <a>

Don't hard code or dynamically generate Salesforce URLs in the `href` attribute of an `<a>` tag. Use events, such as `force:navigateToSObject` or `force:navigateToURL`, instead.

SEE ALSO:

Supporting Accessibility

Anchor Tag: `<a>`

Don't hard code or dynamically generate Salesforce URLs in the `href` attribute of an `<a>` tag. Use events, such as `force:navigateToSObject` or `force:navigateToURL`, instead.

Avoid the `href` Attribute

Using the `href` attribute of an `<a>` tag leads to inconsistent behavior in different apps and shouldn't be relied on. For example, don't use this markup to link to a record:

```
<a href="/XXXXXXXXXXXXXXXXXX">Salesforce record ID (DON'T DO THIS)</a>
```

If you use `#` in the `href` attribute, a secondary issue occurs. The hash mark (#) is a URL fragment identifier and is often used in Web development for navigation within a page. Avoid `#` in the `href` attribute of anchor tags in Lightning components as it can cause unexpected navigation changes, especially in the Salesforce app. That's another reason not to use `href`.

Use Navigation Events

Use one of the navigation events for consistent behavior across Lightning Experience, Salesforce app, and Lightning communities.

`force:navigateToList`
Navigates to a list view.

`force:navigateToObjectHome`
Navigates to an object home.

`force:navigateToRelatedList`
Navigates to a related list.

`force:navigateToSObject`
Navigates to a record.

`force:navigateToURL`
Navigates to a URL.

As well as consistent behavior, using navigation events instead of `<a>` tags reduces the number of full app reloads, leading to better performance.

Example Using Navigation Event

This example uses an <a> tag that's wired to a controller action, which fires the `force:navigateToSObject` event to navigate to a record. The `one.app` container handles the event. This event is supported in Lightning Experience, Salesforce app, and Lightning communities.

```
<!--c:navToRecord-->
<aura:component>
    <aura:attribute name="recordId" type="String" />

    <p><a onclick="{!c.handleClick}">link to record</a></p>
</aura:component>
```

Here is the controller that fires the event.

```
/* navToRecordController.js */
({
    handleClick: function (component, event, helper) {
        var navEvt = $A.get("e.force:navigateToSObject");
        navEvt.setParams({
            "recordId": component.get("v.recordId")
        });
        navEvt.fire();
    }
})
```

The record ID is passed into `c:navToRecord` by setting its `recordId` attribute. When `c:navToRecord` is used in Lightning Experience, Salesforce app, or Lightning communities, the link navigates to the specified record.

CSS in Components

Style your components with CSS.

To add CSS to a component, add a new file to the component bundle called `<componentName>.css`. The framework automatically picks up this new file and auto-wires it when the component is used in a page.

Note: You can't add a `<style>` tag in component markup or when you dynamically create a component in JavaScript code. This restriction ensures better component encapsulation and prevents component styling interfering with the styling of another component. The `<style>` tag restriction applies to components with API version 42.0 or later.

For external CSS resources, see Styling Apps on page 147.

All top-level elements in a component have a special `THIS` CSS class added to them. This, effectively, adds namespacing to CSS and helps prevent one component's CSS from overriding another component's styling. The framework throws an error if a CSS file doesn't follow this convention.

Let's look at a sample `helloHTML.cmp` component. The CSS is in `helloHTML.css`.

Component source

```
<aura:component>
  <div class="white">
    Hello, HTML!
  </div>

  <h2>Check out the style in this list.</h2>
```

```
  <ul>
    <li class="red">I'm red.</li>
    <li class="blue">I'm blue.</li>
    <li class="green">I'm green.</li>
  </ul>
</aura:component>
```

CSS source

```
.THIS {
    background-color: grey;
}

.THIS.white {
    background-color: white;
}

.THIS .red {
    background-color: red;
}

.THIS .blue {
    background-color: blue;
}

.THIS .green {
    background-color: green;
}
```

Output

The top-level elements, `h2` and `ul`, match the `THIS` class and render with a grey background. Top-level elements are tags wrapped by the HTML `body` tag and not by any other tags. In this example, the `li` tags are not top-level because they are nested in a `ul` tag.

The `<div class="white">` element matches the `.THIS.white` selector and renders with a white background. Note that there is no space in the selector as this rule is for top-level elements.

The `<li class="red">` element matches the `.THIS .red` selector and renders with a red background. Note that this is a descendant selector and it contains a space as the `<li>` element is not a top-level element.

SEE ALSO:

Adding and Removing Styles
HTML in Components

Component Attributes

Component attributes are like member variables on a class in Java. They are typed fields that are set on a specific instance of a component, and can be referenced from within the component's markup using an expression syntax. Attributes enable you to make components more dynamic.

Use the `<aura:attribute>` tag to add an attribute to the component or app. Let's look at the following sample, `helloAttributes.app`:

```
<aura:application>
    <aura:attribute name="whom" type="String" default="world"/>
    Hello {!v.whom}!
</aura:application>
```

All attributes have a name and a type. Attributes may be marked as required by specifying `required="true"`, and may also specify a default value.

In this case we've got an attribute named `whom` of type String. If no value is specified, it defaults to "world".

Though not a strict requirement, `<aura:attribute>` tags are usually the first things listed in a component's markup, as it provides an easy way to read the component's shape at a glance.

Now, append `?whom=you` to the URL and reload the page. The value in the query string sets the value of the `whom` attribute. Supplying attribute values via the query string when requesting a component is one way to set the attributes on that component.

Warning: This only works for attributes of type String.

Attribute Naming Rules

An attribute name must follow these naming rules:

- Must begin with a letter or an underscore
- Must contain only alphanumeric or underscore characters

Expressions

`helloAttributes.app` contains an expression, `{!v.whom}`, which is responsible for the component's dynamic output.

`{!`***`expression`***`}` is the framework's expression syntax. In this case, the expression we are evaluating is `v.whom`. The name of the attribute we defined is `whom`, while `v` is the value provider for a component's attribute set, which represents the view.

Note: Expressions are case sensitive. For example, if you have a custom field `myNamespace__Amount__c`, you must refer to it as `{!v.myObject.myNamespace__Amount__c}`.

Attribute Validation

We defined the set of valid attributes in `helloAttributes.app`, so the framework automatically validates that only valid attributes are passed to that component.

Try requesting `helloAttributes.app` with the query string `?fakeAttribute=fakeValue`. You should receive an error that `helloAttributes.app` doesn't have a `fakeAttribute` attribute.

IN THIS SECTION:

SEE ALSO:

Supported aura:attribute Types

Using Expressions

Supported aura:attribute Types

`aura:attribute` describes an attribute available on an app, interface, component, or event.

Attribute Name	Type	Description
`access`	String	Indicates whether the attribute can be used outside of its own namespace. Possible values are `internal` (default), `private`, `public`, and `global`.
`name`	String	Required. The name of the attribute. For example, if you set `<aura:attribute name="isTrue" type="Boolean" />` on a component called `aura:newCmp`, you can set this attribute when you instantiate the component; for example, `<aura:newCmp isTrue="false" />`.
`type`	String	Required. The type of the attribute. For a list of basic types supported, see Basic Types.
`default`	String	The default value for the attribute, which can be overwritten as needed. When setting a default value, expressions using the `$Label`, `$Locale`, and `$Browser` global value providers are supported. Alternatively, to set a dynamic default, use an `init` event. See Invoking Actions on Component Initialization on page 167.
`required`	Boolean	Determines if the attribute is required. The default is `false`.
`description`	String	A summary of the attribute and its usage.
`serializeTo`	String	For optimization. Determines if the attribute is transported from server to client or from client to server. Attributes are transported in JSON format. Valid values are `SERVER`, `BOTH`, or `NONE`. The default is `BOTH`. Specify `SERVER` if you don't want to serialize the attribute to the client.

Attribute Name	Type	Description
		Specify `NONE` if you don't need the attribute to be serialized at all. For example, use `NONE` if it's a client-side only attribute. If you have a JavaScript object array that must be accessible to markup but don't have a requirement on how the objects are constructed, you can use `<aura:attribute name="myObj" type="List" serializeTo="NONE">`.

All `<aura:attribute>` tags have name and type values. For example:

```
<aura:attribute name="whom" type="String" />
```

Note: Although type values are case insensitive, case sensitivity should be respected as your markup interacts with JavaScript, CSS, and Java.

SEE ALSO:

Component Attributes

Basic Types

Here are the supported basic type values. Some of these types correspond to the wrapper objects for primitives in Java. Since the framework is written in Java, defaults, such as maximum size for a number, for these basic types are defined by the Java objects that they map to.

type	Example	Description
`Boolean`	`<aura:attribute name="showDetail" type="Boolean" />`	Valid values are `true` or `false`. To set a default value of `true`, add `default="true"`.
`Date`	`<aura:attribute name="startDate" type="Date" />`	A date corresponding to a calendar day in the format yyyy-mm-dd. The hh:mm:ss portion of the date is not stored. To include time fields, use `DateTime` instead.
`DateTime`	`<aura:attribute name="lastModifiedDate" type="DateTime" />`	A date corresponding to a timestamp. It includes date and time details with millisecond precision.
`Decimal`	`<aura:attribute name="totalPrice" type="Decimal" />`	`Decimal` values can contain fractional portions (digits to the right of the decimal). Maps to java.math.BigDecimal. `Decimal` is better than `Double` for maintaining precision for floating-point calculations. It's preferable for currency fields.
`Double`	`<aura:attribute name="widthInchesFractional" type="Double" />`	`Double` values can contain fractional portions. Maps to java.lang.Double. Use `Decimal` for currency fields instead.

type	Example	Description
`Integer`	`<aura:attribute name="numRecords" type="Integer" />`	`Integer` values can contain numbers with no fractional portion. Maps to java.lang.Integer, which defines its limits, such as maximum size.
`Long`	`<aura:attribute name="numSwissBankAccount" type="Long" />`	`Long` values can contain numbers with no fractional portion. Maps to java.lang.Long, which defines its limits, such as maximum size. Use this data type when you need a range of values wider than those provided by `Integer`.
`String`	`<aura:attribute name="message" type="String" />`	A sequence of characters.

You can use arrays for each of these basic types. For example:

```
<aura:attribute name="favoriteColors" type="String[]" default="['red','green','blue']" />
```

To retrieve a string array from your Java controller, use `List<String>`.

```
public List<String> getStringList() {
    List<String> colors = new List<>();
    colors.add("red");
    colors.add("blue");
    return colors;
}
```

Function Type

An attribute can have a type corresponding to a JavaScript function. If a child component has an attribute of this type, you can pass a callback from a parent component that contains the child component.

```
<aura:attribute name="callback" type="Function" />
```

For an example of using this type with `aura:method`, see Return Result for Asynchronous Code.

Note: Don't send attributes with `type="Function"` to the server. These attributes are intended to only be used on the client side.

The most robust way to communicate between components is to use an event. If you get an error in a component with an attribute of type `Function`, fire an event in the child component instead and handle it in the parent component.

Object Types

An attribute can have a type corresponding to an Object. For example:

```
<aura:attribute name="data" type="Object" />
```

Warning: We recommend using `type="Map"` instead of `type="Object"` to avoid some deserialization issues on the server. For example, when an attribute of `type="Object"` is serialized to the server, everything is converted to a string. Deep expressions, such as `v.data.property` can throw an exception when they are evaluated as a string on the server. Using `type="Map"` avoids these exceptions for deep expressions, and other deserialization issues.

Checking for Types

To determine a variable type, use `typeof` or a standard JavaScript method instead. The `instanceof` operator is unreliable due to the potential presence of multiple windows or frames.

Collection Types

Here are the supported collection type values.

type	Example	Description
type[] (Array)	`<aura:attribute name="colorPalette" type="String[]" default="['red', 'green', 'blue']" />`	An array of items of a defined type.
`List`	`<aura:attribute name="colorPalette" type="List" default="['red', 'green', 'blue']" />`	An ordered collection of items.
`Map`	`<aura:attribute name="sectionLabels" type="Map" default="{ a: 'label1', b: 'label2' }" />`	A collection that maps keys to values. A map can't contain duplicate keys. Each key can map to at most one value. Defaults to an empty object, `{}`. Retrieve values by using `cmp.get("v.sectionLabels")['a']`.
`Set`	`<aura:attribute name="collection" type="Set" default="['red', 'green', 'blue']" />`	A collection that contains no duplicate elements. The order for set items is not guaranteed. For example, `"red,green,blue"` might be returned as `"blue,green,red"`.

Checking for Types

To determine a variable type, use `typeof` or a standard JavaScript method, such as `Array.isArray()`, instead. The `instanceof` operator is unreliable due to the potential presence of multiple windows or frames.

Setting List Items

There are several ways to set items in a list. To use a client-side controller, create an attribute of type List and set the items using `component.set()`.

This example retrieves a list of numbers from a client-side controller when a button is clicked.

```
<aura:attribute name="numbers" type="List"/>
<lightning:button onclick="{!c.getNumbers}" label="Display Numbers" />
<aura:iteration var="num" items="{!v.numbers}">
```

```
  {!num.value}
</aura:iteration>
```

```
/** Client-side Controller **/
({
  getNumbers: function(component, event, helper) {
    var numbers = [];
    for (var i = 0; i < 20; i++) {
      numbers.push({
        value: i
      });
    }
    component.set("v.numbers", numbers);
    }
})
```

To retrieve list data from a model, use `aura:iteration`. This example retrieves data from a model, assuming that you have set the `model` attribute on the `aura:component` tag.

```
<aura:attribute name="sizes" type="List"/>
<aura:iteration items="{!m.sizes}" var="size">
    {!size.value}
</aura:iteration>
```

```
/** Server-side Model **/
@Model
public class MyModel {
    public List<MyDataType> getSizes() {
        ArrayList<MyDataType> s = new ArrayList<MyDataType>(2);
        //Set list items here
        return s;
    }
}
```

Setting Map Items

To add a key and value pair to a map, use the syntax `myMap.set('myNewKey', myNewValue)`.

```
 var myMap = cmp.get("v.sectionLabels");
 myMap.set('c', 'label3');
```

The following example retrieves data from a map.

```
for (var key in myMap){
     //do something
}
```

SEE ALSO:

- Java Models
- Custom Java Class Types
- Java Models
- Custom Java Class Types

Custom Java Class Types

An attribute can have a type corresponding to a Java class. For example, this is an attribute for a `Color` Java class:

```
<aura:attribute name="color" type="java://org.docsample.Color" />
```

If you create a custom Java type, it must implement `JsonSerializable` to enable marshalling from the server to the client.

Support for Collections

If an `<aura:attribute>` can contain more than one element, use a `List` instead of an array.

Note: You can't declare an `<aura:attribute>` to be an array of a custom Java type.

The following `aura:attribute` shows the syntax for a `List` of Java objects:

```
<aura:attribute name="colorPalette" type="List" />
```

You can also use `type="java://List"` instead of `type="List"`. Both definitions are functionally equivalent.

```
<aura:attribute name="colorPalette" type="java://List" />
```

Framework-Specific Types

Here are the supported type values that are specific to the framework.

type	Example	Description
`Aura.Component`	N/A	A single component. We recommend using `Aura.Component[]` instead.

`Aura.Component[]`	`<aura:attribute name="detail" type="Aura.Component[]"/>`
	To set a default value for `type="Aura.Component[]"`, put the default markup in the body of `aura:attribute`. For example:
	`<aura:component>`
	`    <aura:attribute name="detail" type="Aura.Component[]">`
	`    <p>default paragraph1</p>`
	`    </aura:attribute>`
	`    Default value is: {!v.detail}`
	`</aura:component>`
		Use this type to set blocks of markup. An attribute of type `Aura.Component[]` is called a facet.

`Aura.Action`	`<aura:attribute name="onclick" type="Aura.Action"/>`	Use this type to pass an action to a component. See Using the Aura.Action Attribute Type.

IN THIS SECTION:

SEE ALSO:

Component Body

Component Facets

Component Body

Component Facets

Using the Aura.Action Attribute Type

An `Aura.Action` is a reference to an action in the framework. If a child component has an `Aura.Action` attribute, a parent component can pass in an action handler when it instantiates the child component in its markup. This pattern is a shortcut to pass a controller action from a parent component to a child component that it contains, and is used for `on*` handlers, such as `onclick`.

Warning: Although `Aura.Action` works for passing an action handler to a child component, we recommend registering an event in the child component and firing the event in the child's controller instead. Then, handle the event in the parent component. The event approach requires a few extra steps in creating or choosing an event and firing it but events are the standard way to communicate between components.

`Aura.Action` shouldn't be used for other use cases. Here are some known limitations of `Aura.Action`.

- Don't use `cmp.set()` in JavaScript code to reset an attribute of `type="Aura.Action"` after it's previously been set. Doing so generates an error.

```
Unable to set value for key 'c.passedAction'. Value provider does not implement
'set(key, value)'. : false
```

- Don't use `$A.enqueueAction()` in the child component to enqueue the action passed to the `Aura.Action` attribute.

Example

This example demonstrates how to pass an action handler from a parent component to a child component.

Here's the child component with the `Aura.Action` attribute. The `onclick` handler for the button uses the value of the `onclick` attribute, which has type of `Aura.Action`.

```
<!-- child.cmp -->
<aura:component>
    <aura:attribute name="onclick" type="Aura.Action"/>

    <p>Child component with Aura.Action attribute</p>
    <lightning:button label="Execute the passed action" onclick="{!v.onclick}"/>
</aura:component>
```

Here's the parent component that contains the child component in its markup.

```
<!-- parent.cmp -->
<aura:component>
```

```
    <p>Parent component passes handler action to c:child</p>
    <c:child onclick="{!c.parentAction}"/>
</aura:component>
```

When you click the button in `c:child`, the `parentAction` action in the controller of `c:parent` is executed.

Instead of an `Aura.Action` attribute, you could use `<aura:registerEvent>` to register an `onclick` event in the child component. You'd have to define the event and create an action in the child's controller to fire the event. This event-based approach requires a few extra steps but it's more in line with standard practices for communicating between components.

SEE ALSO:

Framework-Specific Types
Handling Events with Client-Side Controllers
Framework-Specific Types
Handling Events with Client-Side Controllers

Component Composition

Composing fine-grained components in a larger component enables you to build more interesting components and applications.

Let's see how we can fit components together. We will first create a few simple components: `c:helloHTML` and `c:helloAttributes`. Then, we'll create a wrapper component, `c:nestedComponents`, that contains the simple components.

Here is the source for `helloHTML.cmp`.

```
<!--c:helloHTML-->
<aura:component>
  <div class="white">
    Hello, HTML!
  </div>

  <h2>Check out the style in this list.</h2>

  <ul>
    <li class="red">I'm red.</li>
    <li class="blue">I'm blue.</li>
    <li class="green">I'm green.</li>
  </ul>
</aura:component>
```

CSS source

```
.THIS {
    background-color: grey;
}

.THIS.white {
    background-color: white;
}

.THIS .red {
    background-color: red;
}
```

```
.THIS .blue {
    background-color: blue;
}

.THIS .green {
    background-color: green;
}
```

Output

Here is the source for `helloAttributes.cmp`.

```
<!--c:helloAttributes-->
<aura:component>
    <aura:attribute name="whom" type="String" default="world"/>
    Hello {!v.whom}!
</aura:component>
```

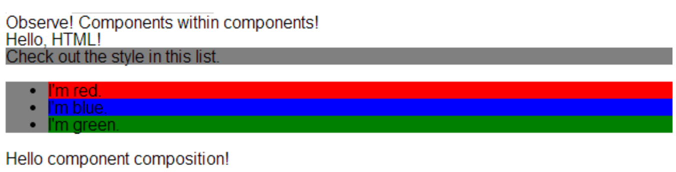
`nestedComponents.cmp` uses composition to include other components in its markup.

```
<!--c:nestedComponents-->
<aura:component>
    Observe!  Components within components!

    <c:helloHTML/>

    <c:helloAttributes whom="component composition"/>
</aura:component>
```

Output



Including an existing component is similar to including an HTML tag. Reference the component by its "descriptor", which is of the form *`namespace`*:*`component`*. `nestedComponents.cmp` references the `helloHTML.cmp` component, which lives in the `c` namespace. Hence, its descriptor is `c:helloHTML`.

Note how `nestedComponents.cmp` also references `c:helloAttributes`. Just like adding attributes to an HTML tag, you can set attribute values in a component as part of the component tag. `nestedComponents.cmp` sets the `whom` attribute of `helloAttributes.cmp` to "component composition".

Attribute Passing

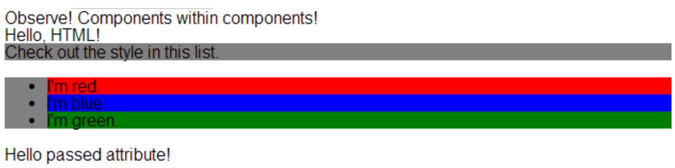
You can also pass attributes to nested components. `nestedComponents2.cmp` is similar to `nestedComponents.cmp`, except that it includes an extra `passthrough` attribute. This value is passed through as the attribute value for `c:helloAttributes`.

```
<!--c:nestedComponents2-->
<aura:component>
    <aura:attribute name="passthrough" type="String" default="passed attribute"/>
    Observe!  Components within components!

    <c:helloHTML/>

    <c:helloAttributes whom="{#v.passthrough}"/>
</aura:component>
```

Output



`helloAttributes` is now using the passed through attribute value.

Note: `{#v.passthrough}` is an unbound expression. This means that any change to the value of the `whom` attribute in `c:helloAttributes` doesn't propagate back to affect the value of the `passthrough` attribute in `c:nestedComponents2`. For more information, see Data Binding Between Components on page 46.

Definitions versus Instances

In object-oriented programming, there's a difference between a class and an instance of that class. Components have a similar concept. When you create a `.cmp` file, you are providing the definition (class) of that component. When you put a component tag in a `.cmp` file, you are creating a reference to (instance of) that component.

It shouldn't be surprising that we can add multiple instances of the same component with different attributes. `nestedComponents3.cmp` adds another instance of `c:helloAttributes` with a different attribute value. The two instances of the `c:helloAttributes` component have different values for their `whom` attribute .

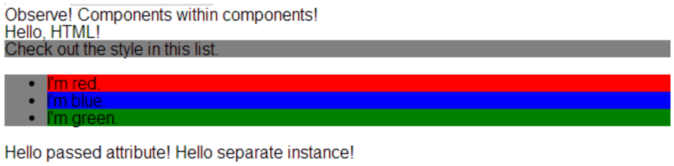
```
<!--c:nestedComponents3-->
<aura:component>
    <aura:attribute name="passthrough" type="String" default="passed attribute"/>
    Observe!  Components within components!

    <c:helloHTML/>

    <c:helloAttributes whom="{#v.passthrough}"/>

    <c:helloAttributes whom="separate instance"/>
</aura:component>
```

Output



Component Body

The root-level tag of every component is `<aura:component>`. Every component inherits the `body` attribute from `<aura:component>`.

The `<aura:component>` tag can contain tags, such as `<aura:attribute>`, `<aura:registerEvent>`, `<aura:handler>`, `<aura:set>`, and so on. Any free markup that is not enclosed in one of the tags allowed in a component is assumed to be part of the body and is set in the `body` attribute.

The `body` attribute has type `Aura.Component[]`. It can be an array of one component, or an empty array, but it's always an array.

In a component, use "`v`" to access the collection of attributes. For example, `{!v.body}` outputs the body of the component.

Setting the Body Content

To set the `body` attribute in a component, add free markup within the `<aura:component>` tag. For example:

```
<aura:component>
    <!--START BODY-->
    <div>Body part</div>
    <lightning:button label="Push Me" onclick="{!c.doSomething}"/>
    <!--END BODY-->
</aura:component>
```

To set the value of an inherited attribute, use the `<aura:set>` tag. Setting the body content is equivalent to wrapping that free markup inside `<aura:set attribute="body">`. Since the `body` attribute has this special behavior, you can omit `<aura:set attribute="body">`.

The previous sample is a shortcut for this markup. We recommend the less verbose syntax in the previous sample.

```
<aura:component>
    <aura:set attribute="body">
        <!--START BODY-->
        <div>Body part</div>
        <lightning:button label="Push Me" onclick="{!c.doSomething}"/>
        <!--END BODY-->
    </aura:set>
</aura:component>
```

The same logic applies when you use any component that has a `body` attribute, not just `<aura:component>`. For example:

```
<lightning:tabset>
    <lightning:tab label="Tab 1">
        Hello world!
    </lightning:tab>
</lightning:tabset>
```

This is a shortcut for:

```
<lightning:tabset>
    <lightning:tab label="Tab 1">
        <aura:set attribute="body">
            Hello World!
        </aura:set>
    </lightning:tab>
</lightning:tabset>
```

Accessing the Component Body

To access a component body in JavaScript, use `component.get("v.body")`.

SEE ALSO:

aura:set

Working with a Component Body in JavaScript

Component Facets

A facet is any attribute of type `Aura.Component[]`. The `body` attribute is an example of a facet.

To define your own facet, add an `aura:attribute` tag of type `Aura.Component[]` to your component. For example, let's create a new component called `facetHeader.cmp`.

```
<!--c:facetHeader-->
<aura:component>
    <aura:attribute name="header" type="Aura.Component[]"/>

    <div>
        <span class="header">{!v.header}</span><br/>
        <span class="body">{!v.body}</span>
    </div>
</aura:component>
```

This component has a header facet. Note how we position the output of the header using the `v.header` expression.

The component doesn't have any output when you access it directly as the `header` and `body` attributes aren't set. Let's create another component, `helloFacets.cmp`, that sets these attributes.

```
<!--c:helloFacets-->
<aura:component>
    See how we set the header facet.<br/>

    <c:facetHeader>

        Nice body!

        <aura:set attribute="header">
            Hello Header!
        </aura:set>
```

```
    </c:facetHeader>

</aura:component>
```

Note that `aura:set` sets the value of the `header` attribute of `facetHeader.cmp`, but you don't need to use `aura:set` if you're setting the `body` attribute.

SEE ALSO:

Component Body

Controlling Access

The framework enables you to control access to your applications, attributes, components, events, interfaces, and methods via the `access` system attribute. The `access` system attribute indicates whether the file can be used outside of its own namespace.

Use the `access` system attribute on these tags:

- `<aura:application>`
- `<aura:attribute>`
- `<aura:component>`
- `<aura:event>`
- `<aura:interface>`
- `<aura:method>`

Access Values

You can specify these values for the `access` system attribute.

Note: If you're an internal Salesforce developer, look at our internal doc as access levels work differently than they do for open-source implementations.

`private`

Available within the component, app, interface, event, or method and can't be referenced outside the file. This value can only be used for `<aura:attribute>` or `<aura:method>`.

Marking an attribute as private makes it easier to refactor the attribute in the future as the attribute can only be used within the file.

Accessing a private attribute returns `undefined` unless you reference it from the component in which it's declared. You can't access a private attribute from a sub-component that extends the component containing the private attribute.

`public`

Available within the same namespace.

`internal`

Available within any internal namespace. An internal namespace is a namespace loaded from the filesystem. This is the default access value.

Resources, such as components, in an internal namespace may access `global`, `internal`, `public` (in the same namespace), or `private` (in the same component) resources.

`global`

Available in all namespaces.

Example

This sample component has global access.

```
<aura:component access="global">
    ...
</aura:component>
```

Access Violations

If your code accesses a resource, such as a component, that doesn't have an `access` system attribute allowing you to access the resource:

- Client-side code doesn't execute or returns `undefined`. You also see an error message in your browser console unless you're running in `PROD` mode.
- Server-side code results in the component failing to load. You also see a popup error message unless you're running in `PROD` mode.

Anatomy of an Access Check Error Message

Here is a sample access check error message for an access violation.

```
Access  Check  Failed ! ComponentService.getDef():'markup://c:targetComponent' is not
visible to 'markup://c:sourceComponent'.
```

An error message has four parts:

1. The context (who is trying to access the resource). In our example, this is `markup://c:sourceComponent`.
2. The target (the resource being accessed). In our example, this is `markup://c:targetComponent`.
3. The type of failure. In our example, this is `not visible`.
4. The code that triggered the failure. This is usually a class method. In our example, this is `ComponentService.getDef()`, which means that the target definition (component) was not accessible. A definition describes metadata for a resource, such as a component.

Fixing Access Check Errors

You can fix access check errors using one or more of these techniques.

- Add appropriate `access` system attributes to the resources that you own.
- Remove references in your code to resources that aren't available. In the earlier example, `markup://c:targetComponent` doesn't have an access value allowing `markup://c:sourceComponent` to access it.
- Ensure that an attribute that you're accessing exists by looking at its `<aura:attribute>` definition. Confirm that you're using the correct case-sensitive spelling for the `name`.

  Accessing an undefined attribute or an attribute that is out of scope, for example a private attribute, triggers the same access violation message. The access context doesn't know whether the attribute is undefined or inaccessible.

Example: `is not visible to 'undefined'`

```
ComponentService.getDef():'markup://c:targetComponent' is not visible to 'undefined'
```

The key word in this error message is `undefined`, which indicates that the framework has lost context. This happens when your code accesses a component outside the normal framework lifecycle, such as in a `setTimeout()` or `setInterval()` call or in an ES6 Promise.

Fix this error by wrapping the code in a `$A.getCallback()` call. For more information, see Modifying Components Outside the Framework Lifecycle.

Example: `Cannot read property 'Yb' of undefined`

```
Action failed: c$sourceComponent$controller$doInit [Cannot read property 'Yb' of undefined]
```

This error message happens when you reference a property on a variable with a value of `undefined`. The error can happen in many contexts, one of which is the side-effect of an access check failure. For example, let's see what happens when you try to access an undefined attribute, `imaginaryAttribute`, in JavaScript.

```
var whatDoYouExpect = cmp.get("v.imaginaryAttribute");
```

This is an access check error and `whatDoYouExpect` is set to `undefined`. Now, if you try to access a property on `whatDoYouExpect`, you get an error.

```
Action failed: c$sourceComponent$controller$doInit [Cannot read property 'Yb' of undefined]
```

The `c$sourceComponent$controller$doInit` portion of the error message tells you that the error is in the `doInit` method of the controller of the `sourceComponent` component in the `c` namespace.

IN THIS SECTION:

Application Access Control

The `access` attribute on the `aura:application` tag controls whether the app can be used outside of the app's namespace.

Interface Access Control

The `access` attribute on the `aura:interface` tag controls whether the interface can be used outside of the interface's namespace.

Component Access Control

The `access` attribute on the `aura:component` tag controls whether the component can be used outside of the component's namespace.

Attribute Access Control

The `access` attribute on the `aura:attribute` tag controls whether the attribute can be used outside of the attribute's namespace.

Event Access Control

The `access` attribute on the `aura:event` tag controls whether the event can be used outside of the event's namespace.

Application Access Control

The `access` attribute on the `aura:application` tag controls whether the app can be used outside of the app's namespace.

Possible values are listed below.

Modifier	Description
`public`	Available within the same namespace.

Modifier	Description
`internal`	Available within any internal namespace. An internal namespace is a namespace loaded from the filesystem. This is the default access value. If set to `internal`, the app isn't directly accessible via a URL in `PROD` mode.
`global`	Available in all namespaces.

Interface Access Control

The `access` attribute on the `aura:interface` tag controls whether the interface can be used outside of the interface's namespace.

Possible values are listed below.

Modifier	Description
`public`	Available within the same namespace.
`internal`	Available within any internal namespace. An internal namespace is a namespace loaded from the filesystem. This is the default access value.
`global`	Available in all namespaces.

An interface can extend another interface but a component can't extend an interface. A component can implement an interface using the `implements` attribute on the `aura:component` tag.

Component Access Control

The `access` attribute on the `aura:component` tag controls whether the component can be used outside of the component's namespace.

Possible values are listed below.

Modifier	Description
`public`	Available within the same namespace.
`internal`	Available within any internal namespace. An internal namespace is a namespace loaded from the filesystem. This is the default access value. If set to `internal`, the component isn't directly accessible via a URL in `PROD` mode.
`global`	Available in all namespaces.

Attribute Access Control

The `access` attribute on the `aura:attribute` tag controls whether the attribute can be used outside of the attribute's namespace.

Possible values are listed below.

Access	Description
`private`	Available within the component, app, interface, event, or method and can't be referenced outside the file. Note: Accessing a private attribute returns `undefined` unless you reference it from the component in which it's declared. You can't access a private attribute from a sub-component that extends the component containing the private attribute.
`public`	Available within the same namespace.
`internal`	Available within any internal namespace. An internal namespace is a namespace loaded from the filesystem. This is the default access value.
`global`	Available in all namespaces.

Event Access Control

The `access` attribute on the `aura:event` tag controls whether the event can be used outside of the event's namespace.

Possible values are listed below.

Modifier	Description
`public`	Available within the same namespace.
`internal`	Available within any internal namespace. An internal namespace is a namespace loaded from the filesystem. This is the default access value.
`global`	Available in all namespaces.

Using Object-Oriented Development

The framework provides the basic constructs of inheritance and encapsulation from object-oriented programming and applies them to presentation layer development.

For example, components are encapsulated and their internals stay private. Consumers of the component can access the public shape (attributes and registered events) of the component, but can't access other implementation details in the component bundle. This strong separation gives component authors freedom to change the internal implementation details and insulates component consumers from those changes.

You can extend a component, app, interface or an event, or you can implement a component interface.

What is Inherited?

This topic lists what is inherited when you extend a definition, such as a component.

When a component contains another component, we refer in the documentation to parent and child components in the containment hierarchy. When a component extends another component, we refer to sub and super components in the inheritance hierarchy.

Component Attributes

A sub component that extends a super component inherits the attributes of the super component. Use `<aura:set>` in the markup of a sub component to set the value of an attribute inherited from a super component.

Events

A sub component that extends a super component can handle events fired by the super component. The sub component automatically inherits the event handlers from the super component.

The super and sub component can handle the same event in different ways by adding an `<aura:handler>` tag to the sub component. The framework doesn't guarantee the order of event handling.

When an event fires, handlers for the event are executed. Handlers for any event that extend the event are also executed.

Helpers

A sub component's helper inherits the methods from the helper of its super component. A sub component can override a super component's helper method by defining a method with the same name as an inherited method.

Controllers

A sub component that extends a super component can call actions in the super component's client-side controller. For example, if the super component has an action called `doSomething`, the sub component can directly call the action using the `{!c.doSomething}` syntax.

Note: We don't recommend using inheritance of client-side controllers as this feature may be deprecated in the future to preserve better component encapsulation. We recommend that you put common code in a helper instead.

Models Are Not Inherited

A component's model is **not** inherited by a component that extends a super component.

SEE ALSO:

Component Attributes

Communicating with Events

Sharing JavaScript Code in a Component Bundle

Handling Events with Client-Side Controllers

aura:set

Java Models

Inherited Component Attributes

A sub component that extends a super component inherits the attributes of the super component.

Attribute values are identical at any level of extension. There is an exception to this rule for the `body` attribute, which we'll look at more closely soon.

Let's start with a simple example. `c:super` has a `description` attribute with a value of "Default description",

```
<!--c:super-->
<aura:component extensible="true">
    <aura:attribute name="description" type="String" default="Default description" />

    <p>super.cmp description: {!v.description}</p>

    {!v.body}
</aura:component>
```

Don't worry about the `{!v.body}` expression for now. We'll explain that when we talk about the `body` attribute.

`c:sub` extends `c:super` by setting `extends="c:super"` in its `<aura:component>` tag.

```
<!--c:sub-->
<aura:component extends="c:super">
    <p>sub.cmp description: {!v.description}</p>
</aura:component
```

Note that `sub.cmp` has access to the inherited `description` attribute and it has the same value in `sub.cmp` and `super.cmp`.

Use `<aura:set>` in the markup of a sub component to set the value of an inherited attribute.

Inherited `body` Attribute

Every component inherits the `body` attribute from `<aura:component>`. The inheritance behavior of `body` is different than other attributes. It can have different values at each level of component extension to enable different output from each component in the inheritance chain. This will be clearer when we look at an example.

Any free markup that is not enclosed in another tag is assumed to be part of the `body`. It's equivalent to wrapping that free markup inside `<aura:set attribute="body">`.

The default renderer for a component iterates through its `body` attribute, renders everything, and passes the rendered data to its super component. The super component can output the data passed to it by including `{!v.body}` in its markup. If there is no super component, you've hit the root component and the data is inserted into `document.body`.

Let's look at a simple example to understand how the `body` attribute behaves at different levels of component extension. We have three components.

`c:superBody` is the super component. It inherently extends `<aura:component>`.

```
<!--c:superBody-->
<aura:component extensible="true">
    Parent body: {!v.body}
</aura:component>
```

At this point, `c:superBody` doesn't output anything for `{!v.body}` as it's just a placeholder for data that will be passed in by a component that extends `c:superBody`.

`c:subBody` extends `c:superBody` by setting `extends="c:superBody"` in its `<aura:component>` tag.

```
<!--c:subBody-->
<aura:component extends="c:superBody">
    Child body: {!v.body}
</aura:component>
```

`c:subBody` outputs:

```
Parent body: Child body:
```

In other words, `c:subBody` sets the value for `{!v.body}` in its super component, `c:superBody`.

`c:containerBody` contains a reference to `c:subBody`.

```
<!--c:containerBody-->
<aura:component>
    <c:subBody>
        Body value
    </c:subBody>
</aura:component>
```

In `c:containerBody`, we set the `body` attribute of `c:subBody` to `Body value`. `c:containerBody` outputs:

```
Parent body: Child body: Body value
```

SEE ALSO:

- aura:set
- Component Body
- Component Markup

Abstract Components

Object-oriented languages, such as Java, support the concept of an abstract class that provides a partial implementation for an object but leaves the remaining implementation to concrete sub-classes. An abstract class in Java can't be instantiated directly, but a non-abstract subclass can.

Similarly, Aura supports the concept of abstract components that have a partial implementation but leave the remaining implementation to concrete sub-components.

To use an abstract component, you must either extend it and fill out the remaining implementation, or add a provider. An abstract component can't be used directly in markup unless you define a provider.

The `<aura:component>` tag has a boolean `abstract` attribute. Set `abstract="true"` to make the component abstract.

SEE ALSO:

- Server-Side Runtime Binding of Components
- Interfaces

Interfaces

Object-oriented languages, such as Java, support the concept of an interface that defines a set of method signatures. A class that implements the interface must provide the method implementations. An interface in Java can't be instantiated directly, but a class that implements the interface can.

Similarly, Aura supports the concept of interfaces that define a component's shape by defining its attributes.

An interface starts with the `<aura:interface>` tag. It can only contain these tags:

- `<aura:attribute>` tags to define the interface's attributes.

- `<aura:registerEvent>` tags to define the events that it may fire.

You can't use markup, renderers, controllers, models, or anything else in an interface.

To use an interface, you must implement it. An interface can't be used directly in markup otherwise. Set the `implements` system attribute in the `<aura:component>` tag to the name of the interface that you are implementing. For example:

```
<aura:component implements="mynamespace:myinterface" >
```

A component can implement an interface and extend another component.

```
<aura:component extends="ns1:cmp1" implements="ns2:intf1" >
```

An interface can extend multiple interfaces using a comma-separated list.

```
<aura:interface extends="ns:intf1,ns:int2" >
```

Note: Use `<aura:set>` in a sub component to set the value of any attribute that is inherited from the super component. This usage works for components and abstract components, but it doesn't work for interfaces. To set the value of an attribute inherited from an interface, redefine the attribute in the sub component using `<aura:attribute>` and set the value in its default attribute.

Since there are fewer restrictions on the content of abstract components, they are more common than interfaces. A component can implement multiple interfaces but can only extend one abstract component, so interfaces can be more useful for some design patterns.

SEE ALSO:
Server-Side Runtime Binding of Components
Setting Attributes Inherited from an Interface
Abstract Components

Marker Interfaces

You can use an interface as a marker interface that is implemented by a set of components that you want to easily identify for specific usage in your app.

In JavaScript, you can determine if a component implements an interface by using `myCmp.isInstanceOf("mynamespace:myinterface")`.

In Java, use the `isInstanceOf()` method in the `ComponentDef` or `ApplicationDef` interfaces.

Inheritance Rules

This table describes the inheritance rules for various elements.

Element	extends	implements	Default Base Element
component	one extensible component	multiple interfaces	`<aura:component>`
app	one extensible app	N/A	`<aura:application>`
interface	multiple interfaces using a comma-separated list (`extends="ns:intf1,ns:int2"`)	N/A	N/A
component event	one component event	N/A	`<aura:componentEvent>`

Element	extends	implements	Default Base Element
application event	one application event	N/A	`<aura:applicationEvent>`

SEE ALSO:

Interfaces

Communicating with Events

Best Practices for Conditional Markup

Using the `<aura:if>` tag is the preferred approach to conditionally display markup but there are alternatives. Consider the performance cost and code maintainability when you design components. The best design choice depends on your use case.

Conditionally Create Elements with `<aura:if>`

Let's look at a simple example that shows an error message when an error occurs.

```
<aura:if isTrue="{!v.isError}">
    <div>{!v.errorMessage}</div>
</aura:if>
```

The `<div>` component and its contents are only created and rendered if the value of the `isTrue` expression evaluates to `true`. If the value of the `isTrue` expression changes and evaluates to `false`, all the components inside the `<aura:if>` tag are destroyed. The components are created again if the `isTrue` expression changes again and evaluates to `true`.

The general guideline is to use `<aura:if>` because it helps your components load faster initially by deferring the creation and rendering of the enclosed element tree until the condition is fulfilled.

Toggle Visibility Using CSS

You can use CSS to toggle visibility of markup by calling `$A.util.toggleClass(cmp, 'class')` in JavaScript code.

Elements in markup are created and rendered up front, but they're hidden. For an example, see Dynamically Showing or Hiding Markup.

The conditional markup is created and rendered even if it's not used, so `<aura:if>` is preferred.

Dynamically Create Components in JavaScript

You can dynamically create components in JavaScript code. However, writing code is usually harder to maintain and debug than using markup. Again, using `<aura:if>` is preferred but the best design choice depends on your use case.

SEE ALSO:

aura:if

Conditional Expressions

Dynamically Creating Components

Component Versioning

Use versioning to change the behavior of a resource, such as a component, while maintaining backwards compatibility for existing users of the resource. Use versioning in markup in applications, components, interfaces, and events.

You can also use versioning in JavaScript controllers, helpers, and renderers, as well as Java controllers.

Versioning in Component Markup

The `{!Version}` expression returns the version of the component in its current context. The current context is defined by the component using the component.

This component uses `{!Version}` to conditionally change the component behavior depending on its version.

```
<!--c:versionedComponent-->
<aura:component>
    <aura:if isTrue="{!Version > 1.0}">
        <c:newVersion />
    </aura:if>
    <c:originalVersion />
</aura:component>
```

`<cOther:consumingComponent>` uses the `<aura:require>` tag to define the version of `<cOther:versionedComponent>` that it uses. In this example, it requires version 2.0 of any resource in the `c` namespace. This sets the context of `<cOther:versionedComponent>` to version 2.0.

```
<!--cOther:consumingComponent-->
<aura:component>
    <aura:require namespace="c" version="2.0" />
    <c:versionedComponent />
</aura:component>
```

Note: The `{!Version}` expression returns a `String`. Depending on how you define version numbers, you may have to define your own comparison logic to work with numbers or other version identifiers, such as `x.y.z`.

Versioning Quick Reference

This table summarizes how to retrieve the current version in different contexts.

Resource	Returns	Syntax
Markup	`String`	`{!Version}`
JavaScript	`String`	`cmp.getVersion()`
Java	`String`	`Aura.getContextService().getCurrentContext().getAccessVersion()`

Using Expressions

Expressions allow you to make calculations and access property values and other data within component markup. Use expressions for dynamic output or passing values into components by assigning them to attributes.

An expression is any set of literal values, variables, sub-expressions, or operators that can be resolved to a single value. Method calls are not allowed in expressions.

The expression syntax is: `{!`***`expression`***`}`

`expression` is a placeholder for the expression.

Anything inside the `{! }` delimiters is evaluated and dynamically replaced when the component is rendered or when the value is used by the component. Whitespace is ignored.

The resulting value can be a primitive, such as an integer, string, or boolean. It can also be a JavaScript object, a component or collection, a controller method such as an action method, and other useful results.

Note: If you're familiar with other languages, you may be tempted to read the `!` as the "bang" operator, which negates boolean values in many programming languages. In Aura, `{!` is simply the delimiter used to begin an expression.

There is a second expression syntax: `{#`***`expression`***`}`. For more details on the difference between the two forms of expression syntax, see Data Binding Between Components.

Identifiers in an expression, such as attribute names accessed through the view, controller values, or labels, must start with a letter or underscore. They can also contain numbers or hyphens after the first character. For example, `{!v.2count}` is not valid, but `{!v.count}` is.

Important: Only use the `{! }` syntax in markup in `.app` or `.cmp` files. In JavaScript, use string syntax to evaluate an expression. For example:

```
var theLabel = cmp.get("v.label");
```

If you want to escape `{!`, use this syntax:

```
<aura:text value="{!"/>
```

This renders `{!` in plain text because the `aura:text` component never interprets `{!` as the start of an expression.

IN THIS SECTION:

Dynamic Output in Expressions

The simplest way to use expressions is to output dynamic values.

Conditional Expressions

Here are examples of conditional expressions using the ternary operator and the `<aura:if>` tag.

Data Binding Between Components

When you add a component in markup, you can use an expression to initialize attribute values in the component based on attribute values of the container component. There are two forms of expression syntax, which exhibit different behaviors for data binding between the components.

Value Providers

Value providers are a way to access data. Value providers encapsulate related values together, similar to how an object encapsulates properties and methods.

Expression Evaluation

Expressions are evaluated much the same way that expressions in JavaScript or other programming languages are evaluated.

Expression Operators Reference

The expression language supports operators to enable you to create more complex expressions.

Expression Functions Reference

The expression language contains math, string, array, comparison, boolean, and conditional functions. All functions are case-sensitive.

Dynamic Output in Expressions

The simplest way to use expressions is to output dynamic values.

Values used in the expression can be from component attributes, literal values, booleans, and so on. For example:

```
{!v.desc}
```

In this expression, `v` represents the view, which is the set of component attributes, and `desc` is an attribute of the component. The expression is simply outputting the `desc` attribute value for the component that contains this markup.

If you're including literal values in expressions, enclose text values within single quotes, such as `{!'Some text'}`.

Include numbers without quotes, for example, `{!123}`.

For booleans, use `{!true}` for `true` and `{!false}` for `false`.

SEE ALSO:

Component Attributes

Value Providers

Conditional Expressions

Here are examples of conditional expressions using the ternary operator and the `<aura:if>` tag.

Ternary Operator

This expression uses the ternary operator to conditionally output one of two values dependent on a condition.

```
<a class="{!v.location == '/active' ? 'selected' : ''}" href="#/active">Active</a>
```

The `{!v.location == '/active' ? 'selected' : ''}` expression conditionally sets the `class` attribute of an HTML `<a>` tag, by checking whether the `location` attribute is set to `/active`. If true, the expression sets `class` to `selected`.

Using `<aura:if>` for Conditional Markup

This snippet of markup uses the `<aura:if>` tag to conditionally display an edit button.

```
<aura:attribute name="edit" type="Boolean" default="true"/>
<aura:if isTrue="{!v.edit}">
    <ui:button label="Edit"/>
    <aura:set attribute="else">
        You can’t edit this.
    </aura:set>
</aura:if>
```

If the `edit` attribute is set to `true`, a `ui:button` displays. Otherwise, the text in the `else` attribute displays.

SEE ALSO:

Best Practices for Conditional Markup

aura:if

Data Binding Between Components

When you add a component in markup, you can use an expression to initialize attribute values in the component based on attribute values of the container component. There are two forms of expression syntax, which exhibit different behaviors for data binding between the components.

This concept is a little tricky, but it will make more sense when we look at an example. Consider a `c:parent` component that has a `parentAttr` attribute. `c:parent` contains a `c:child` component with a `childAttr` attribute that's initialized to the value of the `parentAttr` attribute. We're passing the `parentAttr` attribute value from `c:parent` into the `c:child` component, which results in a data binding, also known as a value binding, between the two components.

```
<!--c:parent-->
<aura:component>
    <aura:attribute name="parentAttr" type="String" default="parent attribute"/>

    <!-- Instantiate the child component -->
    <c:child childAttr="{!v.parentAttr}" />
</aura:component>
```

`{!v.parentAttr}` is a bound expression. Any change to the value of the `childAttr` attribute in `c:child` also affects the `parentAttr` attribute in `c:parent` and vice versa.

Now, let's change the markup from:

```
<c:child childAttr="{!v.parentAttr}" />
```

to:

```
<c:child childAttr="{#v.parentAttr}" />
```

`{#v.parentAttr}` is an unbound expression. Any change to the value of the `childAttr` attribute in `c:child` doesn't affect the `parentAttr` attribute in `c:parent` and vice versa.

Here's a summary of the differences between the forms of expression syntax.

`{#expression}` (Unbound Expressions)

Data updates behave as you would expect in JavaScript. Primitives, such as `String`, are passed by value, and data updates for the expression in the parent and child are decoupled.

Objects, such as `Array` or `Map`, are passed by reference, so changes to the data in the child propagate to the parent. However, change handlers in the parent aren't notified. The same behavior applies for changes in the parent propagating to the child.

`{!expression}` (Bound Expressions)

Data updates in either component are reflected through bidirectional data binding in both components. Similarly, change handlers are triggered in both the parent and child components.

> Tip: Bi-directional data binding is expensive for performance and it can create hard-to-debug errors due to the propagation of data changes through nested components. We recommend using the `{#expression}` syntax instead when you pass an expression from a parent component to a child component unless you require bi-directional data binding.

Unbound Expressions

Let's look at another example of a `c:parentExpr` component that contains another component, `c:childExpr`.

Here is the markup for `c:childExpr`.

```
<!--c:childExpr-->
<aura:component>
```

```
    <aura:attribute name="childAttr" type="String" />

    <p>childExpr childAttr: {!v.childAttr}</p>
    <p><lightning:button label="Update childAttr"
          onclick="{!c.updateChildAttr}"/></p>
</aura:component>
```

Here is the markup for `c:parentExpr`.

```
<!--c:parentExpr-->
<aura:component>
    <aura:attribute name="parentAttr" type="String" default="parent attribute"/>

    <!-- Instantiate the child component -->
    <c:childExpr childAttr="{#v.parentAttr}" />

    <p>parentExpr parentAttr: {!v.parentAttr}</p>
    <p><lightning:button label="Update parentAttr"
          onclick="{!c.updateParentAttr}"/></p>
</aura:component>
```

The `c:parentExpr` component uses an unbound expression to set an attribute in the `c:childExpr` component.

```
<c:childExpr childAttr="{#v.parentAttr}" />
```

When we instantiate `childExpr`, we set the `childAttr` attribute to the value of the `parentAttr` attribute in `c:parentExpr`. Since the `{#v.parentAttr}` syntax is used, the `v.parentAttr` expression is not bound to the value of the `childAttr` attribute.

The `c:exprApp` application is a wrapper around `c:parentExpr`.

```
<!--c:exprApp-->
<aura:application >
    <c:parentExpr />
</aura:application>
```

Navigate to `c:exprApp.app` in your browser.

Both `parentAttr` and `childAttr` are set to “parent attribute”, which is the default value of `parentAttr`.

Now, let’s create a client-side controller for `c:childExpr` so that we can dynamically update the component. Here is the source for `childExprController.js`.

```
/* childExprController.js */
({
    updateChildAttr: function(cmp) {
        cmp.set("v.childAttr", "updated child attribute");
    }
})
```

Navigate to `c:exprApp.app` in your browser again.

Press the **Update childAttr** button. This updates `childAttr` to “updated child attribute”. The value of `parentAttr` is unchanged since we used an unbound expression.

```
<c:childExpr childAttr="{#v.parentAttr}" />
```

Let's add a client-side controller for `c:parentExpr`. Here is the source for `parentExprController.js`.

```
/* parentExprController.js */
({
    updateParentAttr: function(cmp) {
        cmp.set("v.parentAttr", "updated parent attribute");
    }
})
```

Navigate to `c:exprApp.app` in your browser again.

Press the **Update parentAttr** button. This time, `parentAttr` is set to "updated parent attribute" while `childAttr` is unchanged due to the unbound expression.

Warning: Don't use a component's `init` event and client-side controller to initialize an attribute that is used in an unbound expression. The attribute will not be initialized. Use a bound expression instead. For more information on a component's `init` event, see Invoking Actions on Component Initialization on page 167.

Alternatively, you can wrap the component in another component. When you instantiate the wrapped component in the wrapper component, initialize the attribute value instead of initializing the attribute in the wrapped component's client-side controller.

Bound Expressions

Now, let's update the code to use a bound expression instead. Change this line in `c:parentExpr`:

```
<c:childExpr childAttr="{#v.parentAttr}" />
```

to:

```
<c:childExpr childAttr="{!v.parentAttr}" />
```

Navigate to `c:exprApp.app` in your browser again.

Press the **Update childAttr** button. This updates both `childAttr` and `parentAttr` to "updated child attribute" even though we only set `v.childAttr` in the client-side controller of `childExpr`. Both attributes were updated since we used a bound expression to set the `childAttr` attribute.

Change Handlers and Data Binding

You can configure a component to automatically invoke a change handler, which is a client-side controller action, when a value in one of the component's attributes changes.

When you use a bound expression, a change in the attribute in the parent or child component triggers the change handler in both components. When you use an unbound expression, the change is not propagated between components so the change handler is only triggered in the component that contains the changed attribute.

Let's add change handlers to our earlier example to see how they are affected by bound versus unbound expressions.

Here is the updated markup for `c:childExpr`.

```
<!--c:childExpr-->
<aura:component>
    <aura:attribute name="childAttr" type="String" />

    <aura:handler name="change" value="{!v.childAttr}" action="{!c.onChildAttrChange}"/>

    <p>childExpr childAttr: {!v.childAttr}</p>
```

```
    <p><lightning:button label="Update childAttr"
          onclick="{!c.updateChildAttr}"/></p>
</aura:component>
```

Notice the `<aura:handler>` tag with `name="change"`, which signifies a change handler. `value="{!v.childAttr}"` tells the change handler to track the `childAttr` attribute. When `childAttr` changes, the `onChildAttrChange` client-side controller action is invoked.

Here is the client-side controller for `c:childExpr`.

```
/* childExprController.js */
({
    updateChildAttr: function(cmp) {
        cmp.set("v.childAttr", "updated child attribute");
    },

    onChildAttrChange: function(cmp, evt) {
        console.log("childAttr has changed");
        console.log("old value: " + evt.getParam("oldValue"));
        console.log("current value: " + evt.getParam("value"));
    }
})
```

Here is the updated markup for `c:parentExpr` with a change handler.

```
<!--c:parentExpr-->
<aura:component>
    <aura:attribute name="parentAttr" type="String" default="parent attribute"/>

   <aura:handler name="change" value="{!v.parentAttr}" action="{!c.onParentAttrChange}"/>


    <!-- Instantiate the child component -->
    <c:childExpr childAttr="{!v.parentAttr}" />

    <p>parentExpr parentAttr: {!v.parentAttr}</p>
    <p><lightning:button label="Update parentAttr"
          onclick="{!c.updateParentAttr}"/></p>
</aura:component>
```

Here is the client-side controller for `c:parentExpr`.

```
/* parentExprController.js */
({
    updateParentAttr: function(cmp) {
        cmp.set("v.parentAttr", "updated parent attribute");
    },

    onParentAttrChange: function(cmp, evt) {
        console.log("parentAttr has changed");
        console.log("old value: " + evt.getParam("oldValue"));ui
        console.log("current value: " + evt.getParam("value"));
    }
})
```

Navigate to `c:exprApp.app` in your browser again.

Open your browser's console (**More tools** > **Developer tools** in Chrome).

Press the **Update parentAttr** button. The change handlers for `c:parentExpr` and `c:childExpr` are both triggered as we're using a bound expression.

```
<c:childExpr childAttr="{!v.parentAttr}" />
```

Change `c:parentExpr` to use an unbound expression instead.

```
<c:childExpr childAttr="{#v.parentAttr}" />
```

Navigate to `c:exprApp.app` in your browser again.

Press the **Update childAttr** button. This time, only the change handler for `c:childExpr` is triggered as we're using an unbound expression.

SEE ALSO:

Detecting Data Changes with Change Handlers
Dynamic Output in Expressions
Component Composition

Value Providers

Value providers are a way to access data. Value providers encapsulate related values together, similar to how an object encapsulates properties and methods.

The value providers for a component are `m` (model), `v` (view), and `c` (controller).

Value Provider	Description	See Also
`m`	A component's model, which enables the component to initialize its data from a dynamic source, such as a database	Reading Initial Component Data with Models
`v`	A component's attribute set. This value provider enables you to access the value of a component's attribute in the component's markup.	Component Attributes
`c`	A component's controller, which enables you to wire up event handlers and actions for the component	Handling Events with Client-Side Controllers

All components have a `v` value provider, but aren't required to have a controller or model. All three value providers are created automatically when defined for a component.

Note: Expressions are bound to the specific component that contains them. That component is also known as the attribute value provider, and is used to resolve any expressions that are passed to attributes of its contained components.

Global Value Providers

Global value providers are global values and methods that a component can use in expressions.

Global Value Provider	Description	See Also
globalID	The globalId global value provider returns the global ID for a component. Every component has a unique globalId, which is the generated runtime-unique ID of the component instance.	Component IDs
$Browser	The $Browser global value provider returns information about the hardware and operating system of the browser accessing the application.	$Browser
$Label	The $Label global value provider enables you to access labels stored outside your code.	$Label
$Locale	The $Locale global value provider returns information about the current user's preferred locale.	$Locale

To add your own custom global value providers, see Adding Custom Global Value Providers.

Accessing Fields and Related Objects

Values in a value provider are accessed as named properties. To use a value, separate the value provider and the property name with a dot (period). For example, `v.body`. You can access value providers in markup or in JavaScript code.

When an attribute of a component is an object or other structured data (not a primitive value), access the values on that attribute using the same dot notation.

For example, if a component has an attribute `note`, access a note value such as `title` using the `v.note.title` syntax. This example shows usage of this nested syntax for a few attributes.

```
<aura:component>
    <aura:attribute name="note" type="java://org.auraframework.demo.notes.Note"/>
    <ui:block>
        <aura:set attribute="right">
            <ui:outputDateTime value="{#v.note.createdOn}" format="h:mm a"/>
        </aura:set>
    </ui:block>
    {!v.note.title}
</aura:component>
```

Note: `{#v.note.createdOn}` is an unbound expression. This means that any change to the `value` attribute in `ui:outputDateTime` doesn't propagate back to affect the value of the `note` attribute in the parent component. For more information, see Data Binding Between Components on page 46.

For deeply nested objects and attributes, continue adding dots to traverse the structure and access the nested values.

IN THIS SECTION:

Adding Custom Global Value Providers

Add a custom global value provider by implementing the `GlobalValueProviderAdapter` interface.

SEE ALSO:

Dynamic Output in Expressions

$Browser

The `$Browser` global value provider returns information about the hardware and operating system of the browser accessing the application.

Attribute	Description
`formFactor`	Returns a `FormFactor` enum value based on the type of hardware the browser is running on. • DESKTOP for a desktop client • PHONE for a phone including a mobile phone with a browser and a smartphone • TABLET for a tablet client (for which `isTablet` returns `true`)
`isAndroid`	Indicates whether the browser is running on an Android device (`true`) or not (`false`).
`isIOS`	Not available in all implementations. Indicates whether the browser is running on an iOS device (`true`) or not (`false`).
`isIPad`	Not available in all implementations. Indicates whether the browser is running on an iPad (`true`) or not (`false`).
`isIPhone`	Not available in all implementations. Indicates whether the browser is running on an iPhone (`true`) or not (`false`).
`isPhone`	Indicates whether the browser is running on a phone including a mobile phone with a browser and a smartphone (`true`), or not (`false`).
`isTablet`	Indicates whether the browser is running on an iPad or a tablet with Android 2.2 or later (`true`) or not (`false`).
`isWindowsPhone`	Indicates whether the browser is running on a Windows phone (`true`) or not (`false`). Note that this only detects Windows phones and does not detect tablets or other touch-enabled Windows 8 devices.

Example: This example shows usage of the `$Browser` global value provider.

```
<aura:component>
    {!$Browser.isTablet}
    {!$Browser.isPhone}
    {!$Browser.isAndroid}
    {!$Browser.formFactor}
</aura:component>
```

Similarly, you can check browser information in a client-side controller using `$A.get()`.

```
({
    checkBrowser: function(component) {
        var device = $A.get("$Browser.formFactor");
        alert("You are using a " + device);
    }
})
```

`$Locale`

The `$Locale` global value provider returns information about the browser's locale.

These attributes are based on Java's `Calendar`, `Locale` and `TimeZone` classes.

Attribute	Description	Sample Value
`country`	The ISO 3166 representation of the country code based on the language locale.	"US", "DE", "GB"
`currency`	The currency symbol.	"$"
`currencyCode`	The ISO 4217 representation of the currency code.	"USD"
`decimal`	The decimal separator.	"."
`dir`	The direction in which a language is written. Possible values are: "ltr" (left-to-right) or "rtl" (right-to-left).	"ltr", "rtl"
`firstDayOfWeek`	The first day of the week, where 1 is Sunday.	1
`grouping`	The grouping separator.	","
`isEasternNameStyle`	Specifies if a name is based on eastern style, for example, `last name first name [middle] [suffix]`.	false
`labelForToday`	The label for the Today link on the date picker.	"Today"
`language`	The language code based on the language locale.	"en", "de", "zh"
`langLocale`	The locale ID.	"en_US", "en_GB"
`nameOfMonths`	The full and short names of the calendar months	{ fullName: "January", shortName: "Jan" }
`nameOfWeekdays`	The full and short names of the calendar weeks	{ fullName: "Sunday", shortName: "SUN" }
`timezone`	The time zone ID.	"America/Los_Angeles"
`timezoneFileName`	The hyphenated name based on the time zone ID.	"America-Los_Angeles"
`userLocaleCountry`	The country based on the current user's locale	"US"
`userLocaleLang`	The language based on the current user's locale	"en"
`variant`	The vendor and browser-specific code.	"WIN", "MAC", "POSIX"

Number and Date Formatting

The framework's number and date formatting are based on Java's `DecimalFormat` and `DateFormat` classes.

Attribute	Description	Sample Value
`currencyformat`	The currency format.	"¤#,##0.00;(¤#,##0.00)" ¤ represents the currency sign, which is replaced by the currency symbol.
`dateFormat`	The date format.	"MMM d, yyyy"
`datetimeFormat`	The date time format.	"MMM d, yyyy h:mm:ss a"
`numberformat`	The number format.	"#,##0.###" # represents a digit, the comma is a placeholder for the grouping separator, and the period is a placeholder for the decimal separator. Zero (0) replaces # to represent trailing zeros.
`percentformat`	The percentage format.	"#,##0%"
`timeFormat`	The time format.	"h:mm:ss a"
`zero`	The character for the zero digit.	"0"

Example: This example shows how to retrieve different `$Locale` attributes.

Component source

```
<aura:component>
    {!$Locale.language}
    {!$Locale.timezone}
    {!$Locale.numberFormat}
    {!$Locale.currencyFormat}
</aura:component>
```

Similarly, you can check locale information in a client-side controller using `$A.get()`.

```
({
    checkDevice: function(component) {
        var locale = $A.get("$Locale.language");
        alert("You are using " + locale);
    }
})
```

SEE ALSO:

Localization

Adding Custom Global Value Providers

Add a custom global value provider by implementing the `GlobalValueProviderAdapter` interface.

SEE ALSO:
Value Providers
Overriding Default Adapters
Default Adapters

Expression Evaluation

Expressions are evaluated much the same way that expressions in JavaScript or other programming languages are evaluated.

Operators are a subset of those available in JavaScript, and evaluation order and precedence are generally the same as JavaScript. Parentheses enable you to ensure a specific evaluation order. What you may find surprising about expressions is how often they are evaluated. The framework notices when things change, and trigger re-rendering of any components that are affected. Dependencies are handled automatically. This is one of the fundamental benefits of the framework. It knows when to re-render something on the page. When a component is re-rendered, any expressions it uses will be re-evaluated.

Action Methods

Expressions are also used to provide action methods for user interface events: `onclick`, `onhover`, and any other component attributes beginning with "`on`".

Action methods must be assigned to attributes using an expression, for example `{!c.theAction}`. This expression assigns a reference to the controller function that handles the action.

Assigning action methods via expressions allows you to assign them conditionally, based on the state of the application or user interface. For more information, see Conditional Expressions on page 45.

```
<aura:component>
    <aura:attribute name="liked" type="Boolean" default="true"/>
    <lightning:button aura:id="likeBtn"
     label="{!(v.liked) ? 'Like It' : 'Unlike It'}"
     onclick="{!(v.liked) ? c.likeIt  : c.unlikeIt}"
    />
</aura:component>
```

This button will show "Like It" for items that have not yet been liked, and clicking it will call the `likeIt` action method. Then the component will re-render, and the opposite user interface display and method assignment will be in place. Clicking a second time will unlike the item, and so on.

Note: The example demonstrates how attributes can help you control the state of a button. To create a button that toggles between states, we recommend using the `lightning:buttonStateful` component.

Expression Operators Reference

The expression language supports operators to enable you to create more complex expressions.

Arithmetic Operators

Expressions based on arithmetic operators result in numerical values.

Operator	Usage	Description
+	`1 + 1`	Add two numbers.
-	`2 - 1`	Subtract one number from the other.
*	`2 * 2`	Multiply two numbers.
/	`4 / 2`	Divide one number by the other.
%	`5 % 2`	Return the integer remainder of dividing the first number by the second.
-	`-v.exp`	Unary operator. Reverses the sign of the succeeding number. For example if the value of `expenses` is `100`, then `-expenses` is `-100`.

Numeric Literals

Literal	Usage	Description
Integer	`2`	Integers are numbers without a decimal point or exponent.
Float	`3.14` `-1.1e10`	Numbers with a decimal point, or numbers with an exponent.
Null	`null`	A literal null number. Matches the explicit null value **and** numbers with an undefined value.

String Operators

Expressions based on string operators result in string values.

Operator	Usage	Description
+	`'Title: ' + v.note.title`	Concatenates two strings together.

String Literals

String literals must be enclosed in single quotation marks `'like this'`.

Literal	Usage	Description
string	`'hello world'`	Literal strings must be enclosed in single quotation marks. Double quotation marks are reserved for enclosing attribute values, and must be escaped in strings.

Literal	Usage	Description
\<escape>	'\n'	Whitespace characters: • \t (tab) • \n (newline) • \r (carriage return) Escaped characters: • \" (literal ") • \' (literal ') • \\ (literal \)
Unicode	'\u####'	A Unicode code point. The # symbols are hexadecimal digits. A Unicode literal requires four digits.
null	null	A literal null string. Matches the explicit null value and strings with an undefined value.

Comparison Operators

Expressions based on comparison operators result in a true or false value. For comparison purposes, numbers are treated as the same type. In all other cases, comparisons check both value and type.

Operator	Alternative	Usage	Description
==	eq	1 == 1 1 == 1.0 1 eq 1 Note: undefined==null evaluates to true.	Returns true if the operands are equal. This comparison is valid for all data types. Warning: Don't use the == operator for objects, as opposed to basic types, such as Integer or String. For example, object1==object2 evaluates inconsistently on the client versus the server and isn't reliable.
!=	ne	1 != 2 1 != true 1 != '1' null != false 1 ne 2	Returns true if the operands are not equal. This comparison is valid for all data types.
<	lt	1 < 2 1 lt 2	Returns true if the first operand is numerically less than the second. You must escape the < operator to < to use it in component markup. Alternatively, you can use the lt operator.

Operator	Alternative	Usage	Description
`>`	`gt`	`42 > 2` `42 gt 2`	Returns `true` if the first operand is numerically greater than the second.
`<=`	`le`	`2 <= 42` `2 le 42`	Returns `true` if the first operand is numerically less than or equal to the second. You must escape the <= operator to `<=` to use it in component markup. Alternatively, you can use the `le` operator.
`>=`	`ge`	`42 >= 42` `42 ge 42`	Returns `true` if the first operand is numerically greater than or equal to the second.

Logical Operators

Expressions based on logical operators result in a `true` or `false` value.

Operator	Usage	Description
`&&`	`isEnabled && hasPermission`	Returns `true` if both operands are individually true. You must escape the `&&` operator to `&&` to use it in component markup. Alternatively, you can use the `and()` function and pass it two arguments. For example, `and(isEnabled, hasPermission)`.
`||`	`hasPermission || isRequired`	Returns `true` if either operand is individually true.
`!`	`!isRequired`	Unary operator. Returns `true` if the operand is false. This operator should not be confused with the `!` delimiter used to start an expression in `{!`. You can combine the expression delimiter with this negation operator to return the logical negation of a value, for example, `{!!true}` returns `false`.

Logical Literals

Logical values are never equivalent to non-logical values. That is, only `true == true`, and only `false == false`; `1 != true`, and `0 != false`, and `null != false`.

Literal	Usage	Description
true	`true`	A boolean `true` value.
false	`false`	A boolean `false` value.

Conditional Operator

There is only one conditional operator, the traditional ternary operator.

Operator	Usage	Description
`? :`	`(1 != 2) ? "Obviously" : "Black is White"`	The operand before the `?` operator is evaluated as a boolean. If true, the second operand is returned. If false, the third operand is returned.

SEE ALSO:

Expression Functions Reference

Expression Functions Reference

The expression language contains math, string, array, comparison, boolean, and conditional functions. All functions are case-sensitive.

Math Functions

The math functions perform math operations on numbers. They take numerical arguments. The Corresponding Operator column lists equivalent operators, if any.

Function	Alternative	Usage	Description	Corresponding Operator
`add`	`concat`	`add(1,2)`	Adds the first argument to the second.	`+`
`sub`	`subtract`	`sub(10,2)`	Subtracts the second argument from the first.	`-`
`mult`	`multiply`	`mult(2,10)`	Multiplies the first argument by the second.	`*`
`div`	`divide`	`div(4,2)`	Divides the first argument by the second.	`/`
`mod`	`modulus`	`mod(5,2)`	Returns the integer remainder resulting from dividing the first argument by the second.	`%`
`abs`		`abs(-5)`	Returns the absolute value of the argument: the same number if the argument is positive, and the number without its negative sign if the number is negative. For example, `abs(-5) is 5`.	None
`neg`	`negate`	`neg(100)`	Reverses the sign of the argument. For example, `neg(100) is -100`.	`-` (unary)

String Functions

Function	Alternative	Usage	Description	Corresponding Operator
`concat`	`add`	`concat('Hello ', 'world')` `add('Walk ', 'the dog')`	Concatenates the two arguments.	+
`format`		`format($Label.ns.labelName, v.myVal)` Note: This function works for arguments of type `String`, `Decimal`, `Double`, `Integer`, `Long`, `Array`, `String[]`, `List`, and `Set`.	Replaces any parameter placeholders with comma-separated attribute values.	
`join`		`join(separator, subStr1, subStr2, subStrN)` `join(' ','class1', 'class2', v.class)`	Joins the substrings adding the separator String (first argument) between each subsequent argument.	

Label Functions

Function	Usage	Description
`format`	`format($Label.np.labelName, v.attribute1 , v.attribute2)` `format($Label.np.hello, v.name)`	Outputs a label and updates it. Replaces any parameter placeholders with comma-separated attribute values. Supports ternary operators in labels and attributes.

Informational Functions

Function	Usage	Description
`length`	`myArray.length`	Returns the length of an array or a string.
`empty`	`empty(v.attributeName)` Note: This function works for arguments of type `String`, `Array`, `Object`, `List`, `Map`, or `Set`.	Returns `true` if the argument is empty. An empty argument is `undefined`, `null`, an empty array, or an empty string. An object with no properties is not considered empty. Tip: `{! !empty(v.myArray)}` evaluates faster than `{!v.myArray &&`

Function	Usage	Description
		`v.myArray.length > 0}` so we recommend `empty()` to improve performance. The `$A.util.isEmpty()` method in JavaScript is equivalent to the `empty()` expression in markup.

Comparison Functions

Comparison functions take two number arguments and return `true` or `false` depending on the comparison result. The `eq` and `ne` functions can also take other data types for their arguments, such as strings.

Function	Usage	Description	Corresponding Operator
`equals`	`equals(1,1)`	Returns `true` if the specified arguments are equal. The arguments can be any data type.	`==` or `eq`
`notequals`	`notequals(1,2)`	Returns `true` if the specified arguments are not equal. The arguments can be any data type.	`!=` or `ne`
`lessthan`	`lessthan(1,5)`	Returns `true` if the first argument is numerically less than the second argument.	`<` or `lt`
`greaterthan`	`greaterthan(5,1)`	Returns `true` if the first argument is numerically greater than the second argument.	`>` or `gt`
`lessthanorequal`	`lessthanorequal(1,2)`	Returns `true` if the first argument is numerically less than or equal to the second argument.	`<=` or `le`
`greaterthanorequal`	`greaterthanorequal(2,1)`	Returns `true` if the first argument is numerically greather than or equal to the second argument.	`>=` or `ge`

Boolean Functions

Boolean functions operate on Boolean arguments. They are equivalent to logical operators.

Function	Usage	Description	Corresponding Operator
`and`	`and(isEnabled, hasPermission)`	Returns `true` if both arguments are true.	`&&`
`or`	`or(hasPermission, hasVIPPass)`	Returns `true` if either one of the arguments is true.	`||`

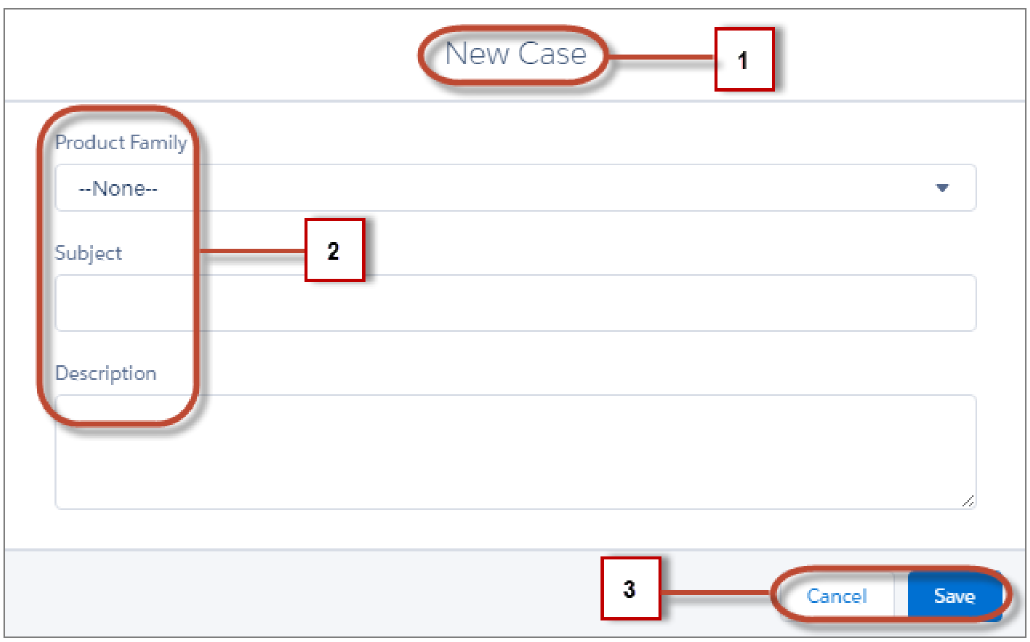
Function	Usage	Description	Corresponding Operator
`not`	`not(isNew)`	Returns `true` if the argument is false.	`!`

Conditional Function

Function	Usage	Description	Corresponding Operator
`if`	`if(isEnabled, 'Enabled', 'Not enabled')`	Evaluates the first argument as a boolean. If true, returns the second argument. Otherwise, returns the third argument.	`?:` (ternary)

Using Labels

Labels are text that presents information about the user interface, such as in the header (1), input fields (2), or buttons (3). While you can specify labels by providing text values in component markup, you can also access labels stored outside your code using the `$Label` global value provider in expression syntax.



This section discusses how to use the `$Label` global value provider in these contexts:

- The `label` attribute in input components
- The `format()` expression function for dynamically populating placeholder values in labels
- The `aura:label` component for populating placeholder values with components or markup in labels
- The `ui:label` component for visual separation with the label's corresponding input component

IN THIS SECTION:

`$Label`

Separating labels from source code makes it easier to translate and localize your applications. Use the `$Label` global value provider to access labels stored outside your code.

`$Label` doesn't have a default implementation but the `LocalizationAdapter` interface assumes that a label has a two-part name: a section name and a label name. This enables you to organize labels into sections with similar labels grouped together.

To customize the behavior of the `$Label` global value provider, see Customizing your Label Implementation on page 68.

Access a label using the dot notation, `$Label.<section>.<labelName>`; for example, `{!$Label.SocialApp.YouLike}`.

Each name must start with a letter or underscore so that the label can be accessed in an expression. For example, `{!$Label.1SocialApp.2YouLike}` is not valid because the section and label name each start with a number.

SEE ALSO:

Localization

Input Component Labels

A label describes the purpose of an input component. To set a label on an input component, use the `label` attribute.

This example shows how to use labels using the `label` attribute on an input component.

```
<ui:inputNumber label="Pick a Number:" labelPosition="top" value="54" />
```

The label position can be `hidden`, `top`, `right`, or `bottom`. The default position is `left`.

Using `$Label`

Use the `$Label` global value provider to access labels stored in an external source. For example:

```
<lightning:input type="number" name="myNumber" label="{!$Label.Number.PickOne}" />
```

To output a label and dynamically update it, use the `format()` expression function. For example, if you have `np.labelName` set to `Hello {0}`, the following expression returns `Hello World` if `v.name` is set to `World`.

```
{!format($Label.np.labelName, v.name)}
```

Separating Labels from Input Components

For design reasons, you might want a significant visual separation of an HTML `<label>` tag from its corresponding form element, In such a scenario, use the `ui:label` component to bind the label to the input component using the local ID, `aura:id`, of the input component.

This code sample shows how to bind a label using the `aura:id` of an input component.

```
<ui:label labelDisplay="false" for="myInput" label="My Input Text" />
<!-- HTML markup separating the label from the input component -->
<ui:inputText aura:id="myInput" value="Put your input here." />
```

Note: We recommend that you use `lightning:input` component, which provides an accessible label for the input component.

To associate the `ui:label` tag with the input component, the `for` attribute in `ui:label` is set to the same value as the `aura:id` in the input component.

Note that setting `labelDisplay="false"` in `ui:label` hides the label from view but still exposes it to screen readers. For more information, refer to the `ui:label` component reference documentation.

SEE ALSO:

Dynamically Populating Label Parameters
Getting Labels in JavaScript
Supporting Accessibility
Java Models

Dynamically Populating Label Parameters

Output and update labels using the `format()` expression function.

You can provide a string with placeholders, which are replaced by the substitution values at runtime.

Add as many parameters as you need. The parameters are numbered and are zero-based. For example, if you have three parameters, they will be named `{0}`, `{1}`, and `{2}`, and they will be substituted in the order they're specified.

Let's look at a custom label, `$Label.mySection.myLabel`, with a value of `Hello {0} and {1}`, where `$Label` is the global value provider that accesses your labels.

This expression dynamically populates the placeholder parameters with the values of the supplied attributes.

```
{!format($Label.mySection.myLabel, v.attribute1, v.attribute2)}
```

The label is automatically refreshed if one of the attribute values changes.

The `format()` expression is more concise and preferred to the equivalent `<aura:label>` markup:

```
<aura:label value="{!$Label.mySection.myLabel}">
    {!v.attribute1}
```

```
    {!v.attribute2}
</aura:label>
```

Note: Always use the `$Label` global value provider to reference a label with placeholder parameters. You can't set a string with placeholder parameters as the first argument for `format()`. For example, this syntax doesn't work:

```
{!format('Hello {0}', v.name)}
```

Use this expression instead.

```
{!format($Label.mySection.salutation, v.name)}
```

where `$Label.mySection.salutation` is set to `Hello {0}`.

Populating Parameters with Components or Markup

You must use `<aura:label>` instead of `format()` to populate parameters with component or markup. For example:

```
<aura:label value="{!$Label.message.hello}">
    <ui:button>{!v.name}</ui:button>
</aura:label>
```

This example shows how to include a link in a label by substituting the `{0}` parameter with the embedded `ui:outputURL` component. The `$Label.MySection.LinkLabel` label is defined as `Label with link: {0}`.

```
<aura:label value="{!$Label.MySection.LinkLabel}">
    <ui:outputURL value="http://www.salesforce.com" label="Test Link"/>
</aura:label>
```

This example is similar to the previous one except that the label value is hard-coded and doesn't use the label provider.

```
<aura:component>
    <aura:label value="Label with link: {0}">
        <ui:outputURL value="http://www.salesforce.com" label="Test Link"/>
    </aura:label>
</aura:component>
```

This is equivalent to embedding the HTML anchor tag:

```
<aura:label value="{!$Label.MySection.LinkLabel}">
    <a href="http://www.salesforce.com">Test Link</a>
</aura:label>
```

Embedding `aura:label` in Another Component

You can use an `aura:label` component with parameter substitutions as the label of another component. For example, you can use an `aura:label` component as the label of a `ui:button` component. Set the `labelDisplay` attribute to `false` so that the label attribute won't be rendered. The embedded label in `aura:label` is displayed instead.

This example embeds the label component from the previous example inside a `ui:button` component. The button label is taken from this embedded label component, which in turn contains an `ui:outputURL` component in its body for substituting a parameter with a link. `$Label.MySection.LinkLabel` is defined as `Label with link: {0}`.

```
<ui:button labelDisplay="false" label="{!$Label.MySection.LinkLabel}">
    <aura:label value="{!$Label.MySection.LinkLabel}">
```

```
        <ui:outputURL value="http://www.salesforce.com" label="Test Link"/>
    </aura:label>
</ui:button>
```

Note: Setting the `labelDisplay` attribute to `false` hides the label provided by the `label` attribute on the `ui:button` component from view, but makes it available to screen readers.

The next example uses a hard-coded label value rather than a value from the label provider. The `{0}` placeholder is replaced by the `Test Link` label at runtime.

```
<aura:component>
    <ui:button labelDisplay="false" label="Label with link: {0}">
        <aura:label value="Label with link: {0}">
            <ui:outputURL value="http://www.salesforce.com" label="Test Link"/>
        </aura:label>
    </ui:button>
</aura:component>
```

Getting Labels in JavaScript

You can retrieve labels in JavaScript code. Your code performs optimally if the labels are statically defined and sent to the client when the component is loaded.

Static Labels

Static labels are defined in one string, such as `"$Label.c.task_mode_today"`. The framework parses static labels in markup or JavaScript code and sends the labels to the client when the component is loaded. A server trip isn't required to resolve the label.

Use `$A.get()` to retrieve static labels in JavaScript code. For example:

```
var staticLabel = $A.get("$Label.c.task_mode_today");
component.set("v.mylabel", staticLabel);
```

Dynamic Labels

`$A.get(`***`labelReference`***`)` must be able to resolve the label reference at compile time, so that the label values can be sent to the client along with the component definition.

If you must defer label resolution until runtime, you can dynamically create labels in JavaScript code. This technique can be useful when you need to use a label, but which specific label isn't known until runtime.

```
// Assume the day variable is dynamically generated
// earlier in the code
// THIS CODE WON'T WORK
var dynamicLabel = $A.get("$Label.c." + day);
```

If the label is already known on the client, `$A.get()` displays the label. If the value is not known, an empty string is displayed in `PROD` mode, or a placeholder value showing the label key is displayed in all other modes.

Using `$A.get()` with a label that can't be determined at runtime means that `dynamicLabel` is an empty string, and won't be updated to the retrieved value. Since the label, `"$Label.c." + day`, is dynamically generated, the framework can't parse it or send it to the client when the component is requested.

There are a few alternative approaches to using `$A.get()` so that you can work with dynamically generated labels.

If your component uses a known set of dynamically constructed labels, you can avoid a server roundtrip for the labels by adding a reference to the labels in a JavaScript resource. The framework sends these labels to the client when the component is requested. For example, if your component dynamically generates `$Label.c.task_mode_today` and `$Label.c.task_mode_tomorrow` label keys, you can add references to the labels in a comment in a JavaScript file, such as a client-side controller or helper.

```
// hints to ensure labels are preloaded
// $Label.c.task_mode_today
// $Label.c.task_mode_tomorrow
```

If your code dynamically generates many labels, this approach doesn't scale well.

If you don't want to add comment hints for all the potential labels, the alternative is to use `$A.getReference()`. This approach comes with the added cost of a server trip to retrieve the label value.

This example dynamically constructs the label value by calling `$A.getReference()` and updates a `tempLabelAttr` component attribute with the retrieved label.

```
var labelSubStr = "task_mode_today";
var labelReference = $A.getReference("$Label.c." + labelSubStr);
cmp.set("v.tempLabelAttr", labelReference);
var dynamicLabel = cmp.get("v.tempLabelAttr");
```

`$A.getReference()` returns a reference to the label. This **isn't** a string, and you shouldn't treat it like one. You never get a string label directly back from `$A.getReference()`.

Instead, use the returned reference to set a component's attribute value. Our code does this in `cmp.set("v.tempLabelAttr", labelReference);`.

When the label value is asynchronously returned from the server, the attribute value is automatically updated as it's a reference. The component is rerendered and the label value displays.

Note: Our code sets `dynamicLabel = cmp.get("v.tempLabelAttr")` immediately after getting the reference. This code displays an empty string until the label value is returned from the server. If you don't want that behavior, use a comment hint to ensure that the label is sent to the client without requiring a later server trip.

SEE ALSO:

Using JavaScript
Input Component Labels
Dynamically Populating Label Parameters
Customizing your Label Implementation
Modes Reference

Setting Label Values via a Parent Attribute

Setting label values via a parent attribute is useful if you want control over labels in child components.

Let's say that you have a container component, which contains another component, `inner.cmp`. You want to set a label value in `inner.cmp` via an attribute on the container component. This can be done by specifying the attribute type and default value. You must set a default value in the parent attribute if you are setting a label on an inner component, as shown in the following example.

This is the container component, which contains a default value `My Label` for the `_label` attribute .

```
<aura:component>
    <aura:attribute name="_label"
```

```
                    type="String"
                    default="My Label"/>
    <lightning:button label="Set Label" aura:id="button1" onclick="{!c.setLabel}"/>
    <auradocs:inner aura:id="inner" label="{!v._label}"/>
</aura:component>
```

This `inner` component contains a text area component and a `label` attribute that's set by the container component.

```
<aura:component>
    <aura:attribute name="label" type="String"/>
    <lightning:textarea aura:id="textarea"
                      name="myTextarea"
                      label="{!v.label}"/>
</aura:component>
```

This client-side controller action updates the label value.

```
({
    setLabel:function(cmp) {
        cmp.set("v._label", 'new label');
    }
})
```

When the component is initialized, you'll see a button and a text area with the label `My Label`. When the button in the container component is clicked, the `setLabel` action updates the label value in the `inner` component. This action finds the `label` attribute and sets its value to `new label`.

SEE ALSO:

Input Component Labels
Component Attributes

Customizing your Label Implementation

You can customize where your app reads labels from by overriding the default label adapter. Your label adapter implementation encapsulates the details of finding and returning labels defined outside the application code. Typically, labels are defined separately from the source code to make localization of labels easier.

To provide a label adapter implementation, implement the `LocalizationAdapter` interface with the following two methods.

```
public class MyLocalizationAdapterImpl implements LocalizationAdapter {

    @Override
    public String getLabel(String section, String name, Object... params) {
        // Return specified label.
    }

    @Override
    public boolean labelExists(String section, String name) {
        // Return true if the label exists; otherwise false.
    }

}
```

The `getLabel` method contains the implementation for finding the specified label and returning it. Here is a description of its parameters:

Parameter	Description
String *section*	The section in the label definition file where the label is defined. This assumes your label name has two parts (section.name). This parameter can be `null` depending on your label system implementation.
String *name*	The label name.
Object *params*	A list of parameter values for substitution on the server. This parameter can be `null` if parameter substitution is done on the client.

The `labelExists` method indicates whether the specified label is defined or not. Its method parameters are identical to the first two parameters for `getLabel`.

SEE ALSO:

Plugging in Custom Code with Adapters

Input Component Labels

Dynamically Populating Label Parameters

Localization

The framework provides client-side localization support on input and output components.

The components retrieve the browser's locale information and display the output components accordingly.

The following example shows how you can override the default `timezone` attribute. The output displays the time in the format `hh:mm` by default.

```
<aura:component>
    <ui:outputDateTime value="2013-10-07T00:17:08.997Z"  timezone="Europe/Berlin" />
</aura:component>
```

The component renders as `Oct 7, 2013 2:17:08 AM`.

To customize the date and time formatting, we recommend using `lightning:formattedDateTime`. This example sets the date and time using the `init` handler.

```
<aura:component>
    <aura:handler name="init" value="{!this}" action="{!c.doInit}"/>
    <aura:attribute name="datetime" type="DateTime"/>
    <lightning:formattedDateTime value="{!v.datetime}" timeZone="Europe/Berlin"
                                year="numeric" month="short" day="2-digit" hour="2-digit"

                                 minute="2-digit" second="2-digit"/>
</aura:component>
```

```
({
    doInit : function(component, event, helper) {
        var date = new Date();
        component.set("v.datetime", date)
```

```
    }
})
```

This example creates a JavaScript Date instance, which is rendered in the format `MMM DD, YYYY HH:MM:SS AM`.

Although the output for this example is similar to `<ui:outputDateTime value="{!v.datetime}" timezone="Europe/Berlin" />`, the attributes on `lightning:formattedDateTime` enable you to control formatting at a granular level. For example, you can display the date using the MM/DD/YYYY format.

```
<lightning:formattedDateTime value="{!v.datetime}" timeZone="Europe/Berlin" year="numeric"
 month="numeric" day="numeric"/>
```

Additionally, you can use the global value provider, `$Locale`, to obtain the locale information. By default, the framework uses the browser's locale, but it can be configured to use others through the global value provider.

SEE ALSO:

Formatting Dates in JavaScript

Providing Component Documentation

Component documentation helps others understand and use your components.

You can provide two types of component reference documentation:

- Documentation definition (DocDef): Full documentation on a component, including a description, sample code, and a reference to an example. DocDef supports extensive HTML markup and is useful for describing what a component is and what it does.
- Inline descriptions: Text-only descriptions, typically one or two sentences, set via the `description` attribute in a tag.

To provide a DocDef, create a `.auradoc` file in the component bundle and use the `<aura:documentation>` tag to wrap your documentation. The following example shows the documentation definition (DocDef) for the `ui:button` component.

Note: DocDef is supported for components, applications, events, and interfaces.

```
<aura:documentation>
  <aura:description>
 <p>
  A <code>ui:button</code> component represents a button element that executes an action
defined by a controller.
              Clicking the button triggers the client-side controller method set for the
<code>press</code> event.
  The button can be created in several ways.
 </p>
 <p>
  A text-only button has only the required <code>label</code> attribute set on it.
  To create a button with both image and text, use the <code>label</code> attribute and
add styles for the button.
 </p>
 <p>The visual appearance of buttons is highly configurable, as are text and accessibility
 attributes.</p>

       <!--More markup here, such as <pre> for code samples-->
       <p>The markup for a button with text and image results in the following HTML. </p>

       <pre>
```

```
             <button class="default uiBlock uiButton" accesskey type="button">
             <img class="icon bLeft" alt="Find" src="path/to/img">
             <span class="label bBody truncate" dir="ltr">Find</span>
             </button>
       </pre>

  </aura:description>
  <aura:example name="buttonExample" ref="uiExamples:buttonExample" label="Using ui:button">

      <p>This example shows a button that displays the icut value you enter.</p>
  </aura:example>
  <aura:example name="buttonSecondExample" ref="uiExamples:buttonSecondExample"
label="Customizing ui:button">
      <p>This example shows a customized <code>ui:button</code> component.</p>
   </aura:example>
</aura:documentation>
```

A documentation definition contains these tags.

Tag	Description
`<aura:documentation>`	The top-level definition of the DocDef
`<aura:description>`	Describes the component using extensive HTML markup. To include code samples in the description, use the `<pre>` tag, which renders as a code block. Code entered in the `<pre>` tag must be escaped. For example, escape `<aura:component>` by entering `<aura:component>`.
`<aura:example>`	References an example that demonstrates how the component is used. Supports extensive HTML markup, which displays as text preceding the visual output and example component source. The example is displayed as interactive output. Multiple examples are supported and should be wrapped in individual `<aura:example>` tags. • `name`: The API name of the example • `ref`: The reference to the example component in the format `<namespace:exampleComponent>` • `label`: The label of the title

Providing an Example Component

Recall that the DocDef includes a reference to an example component. The example component is rendered as an interactive demo in the component reference documentation when it’s wired up using `aura:example`.

```
<aura:example name="buttonExample" ref="uiExamples:buttonExample" label="Using ui:button">
```

The following is an example component that demonstrates how `ui:button` can be used.

```

<!--The uiExamples:buttonExample example component -->
<aura:component>
   <ui:inputText aura:id="name" label="Enter Name:" placeholder="Your Name" />
   <ui:button aura:id="button" buttonTitle="Click to see what you put into the field"
```

```
              class="button" label="Click me" press="{!c.getInput}" />
   <ui:outputText aura:id="outName" value="" class="text" />
</aura:component>
```

Supported HTML Tags in Document Definitions

Some HTML tags are unsafe or unnecessary. The framework doesn't support these tags in document definitions.

The `SUPPORTED_HTML_TAGS` key in this open-source Aura file lists the supported HTML tags. The `SUPPORTED_ATTRS` key lists the supported HTML tag attributes.

Providing Inline Descriptions

Inline descriptions provide a brief overview of what an element is about. HTML markup is not supported in inline descriptions. These tags support inline descriptions via the `description` attribute.

Tag	Example
`<aura:component>`	`<aura:component description="Represents a button element">`
`<aura:attribute>`	`<aura:attribute name="label" type="String" description="The text to be displayed inside the button."/>`
`<aura:event>`	`<aura:event type="COMPONENT" description="Indicates that a keyboard key has been pressed and released"/>`
`<aura:interface>`	`<aura:interface description="A common interface for date components"/>`
`<aura:registerEvent>`	`<aura:registerEvent name="keydown" type="ui:keydown" description="Indicates that a key is pressed"/>`

SEE ALSO:

Reference

Working with UI Components

The framework provides common user interface components in the `ui` namespace. All of these components extend either `aura:component` or a child component of `aura:component`. `aura:component` is an abstract component that provides a default rendering implementation. User interface components such as `ui:input` and `ui:output` provide easy handling of common user interface events like keyboard and mouse interactions. Each component can be styled and extended accordingly.

Note: If you are looking for components that apply the Lightning Design System styling, consider using the base lightning components instead.

Complex, Interactive Components

The following components contain one or more sub-components and are interactive.

Type	Key Components	Description
Autocomplete	`ui:autocomplete`	An input field that suggests a list of values as you type
Carousel	`ui:carousel`	A list of pages that can be swiped horizontally
	`ui:carouselPage`	A scrollable page in a `ui:carousel` component
Dialog	`ui:panel`	A modal or non-modal overlay
	`ui:panelManager2`	A component that instantiates and handles panels
Message	`ui:message`	A message notification of varying severity levels
Menu	`ui:menu`	A drop-down list with a trigger that controls its visibility. This component extends `ui:popup`.
	`ui:menuList`	A list of menu items
	`ui:actionMenuItem`	A menu item that triggers an action
	`ui:checkboxMenuItem`	A menu item that supports multiple selection and can be used to trigger an action
	`ui:radioMenuItem`	A menu item that supports single selection and can be used to trigger an action
	`ui:menuItemSeparator`	A visual separator for menu items
	`ui:menuItem`	An abstract and extensible component for menu items in a `ui:menuList` component
	`ui:menuTrigger`	A trigger that expands and collapses a menu
	`ui:menuTriggerLink`	A link that triggers a dropdown menu. This component extends `ui:menuTrigger`
Popup	`ui:popup`	A popup with a trigger that controls its visibility. Used by `ui:menu`
	`ui:popupTarget`	A container that's displayed in response to a trigger.
	`ui:popupTrigger`	A trigger that expands and collapses a menu.
Tabset	`ui:tab`	A single tab in a `ui:tabset` component
	`ui:tabBar`	A list wrapper for tabs in a `ui:tabset` component
	`ui:tabItem`	A single tab that's rendered by a `ui:tabBar` component
	`ui:tabset`	A set of tabs that's displayed in an unordered list

Input Control Components

The following components are interactive, for example, like buttons and checkboxes.

Type	Key Components	Description
Button	`ui:button`	An actionable button that can be pressed or clicked

Type	Key Components	Description
Checkbox	`ui:inputCheckbox`	A selectable option that supports multiple selections
	`ui:outputCheckbox`	Displays a read-only value of the checkbox
Radio button	`ui:inputRadio`	A selectable option that supports only a single selection
Drop-down List	`ui:inputSelect`	A drop-down list with options
	`ui:inputSelectOption`	An option in a `ui:inputSelect` component
	`ui:inputSelectOptionGroup`	

Visual Components

The following components provides informative cues, for example, like error messages and loading spinners.

Type	Key Components	Description
Field-level error	`ui:inputDefaultError`	An error message that is displayed when an error occurs
Input Label	`ui:label`	A text label that binds to an input component
Layout	`ui:block`	A horizontal layout that provides two or three columns
	`ui:vbox`	A vertical layout that provides two or three rows
List	`ui:list`	A collection of items that can be iterated over and displayed
Spinner	`ui:spinner`	A loading spinner

Field Components

The following components enables you to enter or display values.

Type	Key Components	Description
Currency	`ui:inputCurrency`	An input field for entering currency
	`ui:outputCurrency`	Displays currency in a default or specified format
Email	`ui:inputEmail`	An input field for entering an email address
	`ui:outputEmail`	Displays a clickable email address
Date and time	`ui:inputDate`	An input field for entering a date
	`ui:inputDateTime`	An input field for entering a date and time
	`ui:outputDate`	Displays a date in the default or specified format
	`ui:outputDateTime`	Displays a date and time in the default or specified format
Password	`ui:inputSecret`	An input field for entering secret text

Type	Key Components	Description
Percentage	ui:inputPercent	An input field for entering a percentage
	ui:outputPercent	Displays a percentage in the default or specified format
Phone Number	ui:inputPhone	An input field for entering a telephone number
	ui:outputPhone	Displays a phone number
Number	ui:inputNumber	An input field for entering a numerical value
	ui:outputNumber	Displays a number
Range	ui:inputRange	An input field for entering a value within a range
Rich Text	ui:inputRichText	An input field for entering rich text
	ui:outputRichText	Displays rich text
Search	ui:inputSearch	An input field for entering a search string
Text	ui:inputText	An input field for entering a single line of text
	ui:outputText	Displays text
Text Area	ui:inputTextArea	An input field for entering multiple lines of text
	ui:outputTextArea	Displays a read-only text area
URL	ui:inputURL	An input field for entering a URL
	ui:outputURL	Displays a clickable URL

SEE ALSO:
Using the UI Components
Creating Components
Component Bundles

Event Handling in UI Components

UI components provide easy handling of user interface events such as keyboard and mouse interactions. By listening to these events, you can also bind values on UI input components using the `updateon` attribute, such that the values update when those events are fired.

Capture a UI event by defining its handler on the component. For example, you want to listen to the HTML DOM event, `onblur`, on a `ui:inputTextArea` component.

```
<ui:inputTextArea aura:id="textarea" value="My text area" label="Type something"
      blur="{!c.handleBlur}" />
```

The `blur="{!c.handleBlur}"` listens to the `onblur` event and wires it to your client-side controller. When you trigger the event, the following client-side controller handles the event.

```
handleBlur : function(cmp, event, helper){
    var elem = cmp.find("textarea").getElement();
```

```
    //do something else
}
```

These events are available to any components that implement the `ui:visible` and `ui:uiEvents` interfaces. The `ui:visible` interface provides event registration for mouse events and attributes that defines a component's class and label. The `ui:uiEvents` interface provides event registration for form events, such as `blur` and `focus`.

For all available events on all components, refer to the Reference Doc App on page 314.

Value Binding for Browser Events

Any changes to the UI are reflected in the component attribute, and any change in that attribute is propagated to the UI. When you load the component, the value of the input elements are initialized to those of the component attributes. Any changes to the user input causes the value of the component variable to be updated. For example, a `ui:inputText` component can contain a value that's bound to a component attribute, and the `ui:outputText` component is bound to the same component attribute. The `ui:inputText` component listens to the `onkeyup` browser event and updates the corresponding component attribute values.

```
<aura:attribute name="first" type="String" default="John"/>
<aura:attribute name="last" type="String" default="Doe"/>

<ui:inputText label="First Name" value="{!v.first}" updateOn="keyup"/>
<ui:inputText label="Last Name" value="{!v.last}" updateOn="keyup"/>

<!-- Returns "John Doe" -->
<ui:outputText value="{!v.first +' '+ v.last}"/>
```

The next example takes in numerical inputs and returns the sum of those numbers. The `ui:inputNumber` component listens to the `onkeyup` browser event. When the value in this component changes on the keyup event, the value in the `ui:outputNumber` component is updated as well, and returns the sum of the two values.

```
<aura:attribute name="number1" type="integer" default="1"/>
<aura:attribute name="number2" type="integer" default="2"/>

<ui:inputNumber label="Number 1" value="{!v.number1}" updateOn="keyup" />
<ui:inputNumber label="Number 2" value="{!v.number2}"  updateOn="keyup" />

<!-- Adds the numbers and returns the sum -->
<ui:outputNumber  value="{!(v.number1 * 1) + (v.number2 * 1)}"/>
```

Note: The input fields return a string value and must be properly handled to accommodate numerical values. In this example, both values are multiplied by 1 to obtain their numerical equivalents.

Using the UI Components

Users interact with your app through input elements to select or enter values. Components such as `ui:inputText` and `ui:inputCheckbox` correspond to common input elements. These components simplify event handling for user interface events.

Note: For all available component attributes and events, see the component reference at `http://<myServer>/auradocs/reference.app`.

To use input components in your own custom component, add them to your `.cmp` or `.app` file. This example is a basic set up of a text field and button. The `aura:id` attribute defines a unique ID that enables you to reference the component from your JavaScript code using `cmp.find("myID");`.

```
<ui:inputText label="Name" aura:id="name" placeholder="First, Last"/>
<ui:outputText aura:id="nameOutput" value=""/>
<ui:button aura:id="outputButton" label="Submit" press="{!c.getInput}"/>
```

Note: All text fields must specify the `label` attribute to provide a textual label of the field. If you must hide the label from view, set `labelClass="assistiveText"` to make the label available to assistive technologies.

The `ui:outputText` component acts as a placeholder for the output value of its corresponding `ui:inputText` component. The value in the `ui:outputText` component can be set with the following client-side controller action.

```
getInput : function(cmp, event) {
      var fullName = cmp.find("name").get("v.value");
      var outName = cmp.find("nameOutput");
      outName.set("v.value", fullName);
    }
```

The following example is similar to the previous, but uses value binding without a client-side controller. The `ui:outputText` component reflects the latest value on the `ui:inputText` component when the `onkeyup` browser event is fired.

```
<aura:attribute name="first" type="String" default="John"/>
<aura:attribute name="last" type="String" default="Doe"/>

<ui:inputText label="First Name" value="{!v.first}" updateOn="keyup"/>
<ui:inputText label="Last Name" value="{!v.last}" updateOn="keyup"/>

<!-- Returns "John Doe" -->
<ui:outputText value="{!v.first +' '+ v.last}"/>
```

Date and Time Fields

Date and time fields provide client-side localization, date picker support, and support for common keyboard and mouse events. If you want to render the output from these field components, use the respective `ui:output` components. For example, to render the output for the `ui:inputDate` component, use `ui:outputDate`.

Date and Time fields are represented by the following components.

Field Type	Description	Related Components
Date	An input field for entering a date of type `text`. Provide a date picker by setting `displayDatePicker="true"`. Web apps running on mobiles and tablets use an input field of type `date`.	`ui:inputDate` `ui:outputDate`
Date and Time	An input field for entering a date and time of type `text`. Provide a date picker and time picker by setting `displayDatePicker="true"`. On desktop, the date and time fields display as two separate fields. The time picker displays	`ui:inputDateTime` `ui:outputDateTime`

Field Type	Description	Related Components
	a list of time in 30-minute increments. Web apps running on mobiles and tablets use an input field of type `datetime-local`.	

Using the Date and Time Fields

This is a basic set up of a date field with a date picker.

```
<ui:inputDate aura:id="dateField" label="Birthday" value="2000-01-01"
displayDatePicker="true"/>
```

This example results in the following HTML.

```
<div class="uiInput uiInputDate uiInput--default uiInput--input uiInput--datetime">
  <label class="uiLabel-left form-element__label uiLabel">
    <span>Birthday</span>
  </label>
  <form class="form--stacked form-element">
      <input placeholder="MMM d, yyyy" type="text">
      <a class="datePicker-openIcon display" aria-haspopup="true">
          <span class="assistiveText">Date Picker</span>
      </a>
  <a class="clearIcon hide">
    <span class="assistiveText">Clear Button</span>
  </a>
  </form>
</div>
<div class="DESKTOP uiDatePicker--default uiDatePicker">
    <!--Date picker set to visible when icon is clicked-->
</div>
```

Styling Your Date and Time Fields

You can style the appearance of your date and time field and output in the CSS file of your component.

The following example provides styles to a `ui:inputDateTime` component with the `myStyle` selector.

```
<!-- Component markup -->
<ui:inputDateTime class="myStyle" label="Date" displayDatePicker="true"/>

/* CSS */
.THIS .myStyle {
  border: 1px solid #dce4ec;
```

```
  border-radius: 4px;
}
```

SEE ALSO:

Input Component Labels

Handling Events with Client-Side Controllers

Localization

CSS in Components

Number Fields

Number fields can contain a numerical value. They support client-side formatting, localization, and common keyboard and mouse events.

If you want to render the output from these field components, use the respective `ui:output` components. For example, to render the output for the `ui:inputNumber` component, use `ui:outputNumber`.

Number fields are represented by the following components.

Type	Related Components	Description
Number	`ui:inputNumber`	An input field for entering a numerical value
	`ui:outputNumber`	Displays a number
Currency	`ui:inputCurrency`	An input field for entering currency
	`ui:outputCurrency`	Displays currency
Percentage	`ui:inputPercent` `ui:outputPercent`	An input field for entering a numerical percentage value.
Range	`ui:inputRange`	A slider for numerical input.

Using the Number Fields

This example shows a basic set up of a percentage number field, which displays `50%` in the field.

```
<ui:label label="Discount" for="discountField"/>
<ui:inputPercent aura:id="discountField" value="0.5"/>
```

This is a basic set up of a range input, with the `min` and `max` attributes.

```
<ui:label label="Quantity" for="qtyField"/>
<ui:inputRange aura:id="qtyField" min="1" max="10"/>
```

`ui:label` provides a text label for the corresponding field.

These examples result in the following HTML.

```
<label for="globalId" class="uiLabel"><span>Discount</span></label>
<iput aria-describedby max="99999999999999" step="1" placeholder type="text"
min="-99999999999999" id="globalId" class="uiInput uiInputText uiInputNumber uiInputPercent">
```

```
<label for="globalId" class="uiLabel"><span>Quantity</span></label>
<input max="10" step="1" type="range" min="1" id="globalId" class="uiInput uiInputText
uiInputNumber uiInputRange">
```

Returning a Valid Number

The value of the `ui:inputNumber` component expects a valid number and won't work with commas. If you want to include commas, use `type="Integer"` instead of `type="String"`.

This example returns `100,000`.

```
<aura:attribute name="number" type="Integer" default="100,000"/>
<ui:inputNumber label="Number" value="{#v.number}"/>
```

Note: `{#v.number}` is an unbound expression. This means that any change to the `value` attribute in `ui:inputNumber` doesn't propagate back to affect the value of the `number` attribute in the parent component. For more information, see Data Binding Between Components on page 46.

This example also returns `100,000`.

```
<aura:attribute name="number" type="String" default="100000"/>
<ui:inputNumber label="Number" value="{#v.number}"/>
```

Formatting and Localizing the Number Fields

The `format` attribute determines the format of the number input. The Locale default format is used if none is provided. The following code is a basic set up of a number field, which displays `10,000.00` based on the provided `format` attribute.

```
<ui:inputNumber label="Cost" aura:id="costField" format="#,##0,000.00#" value="10000"/>
```

The following code is a basic set up of a percentage field with client-side formatting, which displays `14.000%` based on the provided `format` attribute.

```
<ui:outputPercent label="Growth" aura:id="pField" value="0.14" format=".000%"/>
```

The following code is a basic set up of a currency field with localization, which displays `£10.00` based on the provided `currencySymbol` and `format` attributes. You can also set the `currencyCode` attribute with an ISO 4217 currency code, such as `USD` or `GBP`.

```
<ui:outputCurrency value="10" currencySymbol="£" format="¤.00" />
```

Number and Currency Shortcuts

Users can enter the shortcuts **k**, **m**, **b**, **t** to indicate thousands, millions, billions, or trillions in `ui:inputNumber` and `ui:inputCurrency` components. This feature is available in Lightning Experience, and all versions of the Salesforce mobile app.

Styling Your Number Fields

You can style the appearance of your number field and output. In the CSS file of your component, add the corresponding class selectors. The following class selectors provide styles to the string rendering of the numbers. For example, to style the `ui:inputCurrency` component, use `.THIS .uiInputCurrency`, or `.THIS.uiInputCurrency` if it's a top-level element.

The following example provides styles to a `ui:inputNumber` component with the `myStyle` selector.

```
<!-- Component markup -->
<ui:inputNumber class="myStyle" label="Amount" placeholder="0" />

/* CSS */
.THIS .myStyle {
  border: 1px solid #dce4ec;
  border-radius: 4px;
}
```

SEE ALSO:

Input Component Labels

Handling Events with Client-Side Controllers

Localization

CSS in Components

Text Fields

A text field can contain alphanumerical characters and special characters. They provide common keyboard and mouse events. If you want to render the output from these field components, use the respective `ui:output` components. For example, to render the output for the `ui:inputPhone` component, use `ui:outputPhone`.

Text fields are represented by the following components.

Type	Related Components	Description
Email	`ui:inputEmail`	An input field for entering an email address
	`ui:outputEmail`	Displays a clickable email address
Password	`ui:inputSecret`	An input field for entering secret text
Phone Number	`ui:inputPhone`	An input field for entering a telephone number
	`ui:outputPhone`	Displays a clickable phone number
Rich Text	`ui:inputRichText`	An input field for entering rich text
	`ui:outputRichText`	Displays rich text
Search	`ui:inputSearch`	An input field for entering a search term.
Text	`ui:inputText`	An input field for entering single line of text
	`ui:outputText`	Displays text

Type	Related Components	Description
Text Area	ui:inputTextArea	An input field for entering multiple lines of text
	ui:outputTextArea	Displays a read-only text area
URL	ui:inputURL	An input field for entering a URL
	ui:outputURL	Displays a clickable URL

Using the Text Fields

Text fields are typically used in a form. For example, this is a basic set up of an email field.

```
<ui:inputEmail aura:id="email" label="Email" placeholder="abc@email.com"/>
```

This example results in the following HTML.

```
<div class="uiInput uiInputEmail uiInput--default uiInput--input">
  <label class="uiLabel-left form-element__label uiLabel">
    <span>Email</span>
  </label>
  <input placeholder="abc@email.com" type="email" class="input">
</div>
```

Providing Auto-complete Suggestions in Text Fields

Auto-complete is available with the `ui:autocomplete` component, which uses a text or text area of its own. To use a text area, set the `inputType="inputTextArea"`. The default is `inputText`.

Styling Your Text Fields

You can style the appearance of your text field and output. In the CSS file of your component, add the corresponding class selectors.

For example, to style the `ui:inputPhone` component, use `.THIS .uiInputPhone`, or `.THIS.uiInputPhone` if it's a top-level element.

The following example provides styles to a `ui:inputText` component with the `myStyle` selector.

```
<!-- Component markup-->
<ui:inputText class="myStyle" label="Name"/>

/* CSS */
.THIS .myStyle {
  border: 1px solid #dce4ec;
```

```
  border-radius: 4px;
}
```

SEE ALSO:

- Rich Text Fields
- Input Component Labels
- Handling Events with Client-Side Controllers
- Localization
- CSS in Components

Rich Text Fields

`ui:inputRichText` is an input field for entering rich text. The following code shows a basic implementation of this component, which is rendered as a text area and button. A button click runs the client-side controller action that returns the input value in a `ui:outputRichText` component. In this case, the value returns “Aura” in bold, and “input rich text demo” in red.

```
<!--Rich text demo-->
  <ui:inputRichText isRichText="false" aura:id="inputRT" label="Rich Text Demo"
    cols="50" rows="5" value="&lt;b&gt;Aura&lt;/b&gt;, &lt;span style='color:red'&gt;input
 rich text demo&lt;/span&gt;"/>
  <ui:button aura:id="outputButton"
    buttonTitle="Click to see what you put into the rich text field"
    label="Display" press="{!c.getInput}"/>
  <ui:outputRichText aura:id="outputRT" value=" "/>
```

```
/*Client-side controller*/
  getInput : function(cmp) {
    var userInput = cmp.find("inputRT").get("v.value");
    var output = cmp.find("outputRT");
    output.set("v.value", userInput);
  }
```

In this demo, the `isRichText="false"` attribute replaces the component with the `ui:inputTextArea` component. The WYSIWYG rich text editor is provided when this attribute is not set, as shown below.

The width and height of the rich text editor are independent of those on the `ui:inputTextArea` component. To set the width and height of the component when you set `isRichText="false"`, use the `cols` and `rows` attributes. Otherwise, use the `width` and `height` attributes.

SEE ALSO:

- Text Fields

Checkboxes

Checkboxes are clickable and actionable, and they can be presented in a group for multiple selection. You can create a checkbox with `ui:inputCheckbox`, which inherits the behavior and events from `ui:input`. The `value` and `disabled` attributes control the state of a checkbox, and events such as `click` and `change` determine its behavior. Events must be used separately on each checkbox.

Here are several basic ways to set up a checkbox.

Checked

To select the checkbox, set `value="true"`. Alternatively, `value` can take in a value from a model.

```
<ui:inputCheckbox value="true"/>
```

```
<!--Initializing the component-->
<ui:inputCheckbox aura:id="inCheckbox" value="{!m.checked}"/>

//Initializing with a model
public Boolean getChecked() {
    return true;
}
```

The model is in a Java class specified by the `model` attribute on the `aura:component` tag.

Disabled State

```
<ui:inputCheckbox disabled="true" label="Select" />
```

The previous example results in the following HTML.

```
<div class="uiInput uiInputCheckbox uiInput--default uiInput--checkbox">
<label class="uiLabel-left form-element__label uiLabel"
for="globalId"><span>Select</span></label>
<input disabled="disabled" type="checkbox id="globalId">
```

Working with Events

Common events for `ui:inputCheckbox` include the `click` and `change` events. For example, `click="{!c.done}"` calls the client-side controller action with the function name, `done`.

The following code crosses out the checkbox item.

```
<!--The checkbox-->
    <ui:inputCheckbox label="Cross this out" click="{!c.crossout}" class="line" />

    /*The controller action*/
    crossout : function(cmp, event){
        var cmpSource = event.getSource();
        $A.util.toggleClass(cmpSource, "done");
     }
```

SEE ALSO:

Java Models

Handling Events with Client-Side Controllers

CSS in Components

Radio Buttons

Radio buttons are clickable and actionable, and they can only be individually selected when presented in a group. You can create a radio button with `ui:inputRadio`, which inherits the behavior and events from `ui:input`. The `value` and `disabled` attributes control the state of a radio button, and events such as `click` and `change` determine its behavior. Events must be used separately on each radio button.

If you want to use radio buttons in a menu, use `ui:radioMenuItem` instead.

Here are several basic ways to set up a radio button.

Selected

To select the radio button, set `value="true"`.

```
<ui:inputRadio value="true" label="Select?"/>
```

Disabled State

```
<ui:inputRadio label="Select" disabled="true"/>
```

The previous example results in the following HTML.

```
<div class="uiInput uiInputRadio uiInput--default uiInput--radio">
    <label class="uiLabel-left form-element__label uiLabel"
for="globalId"><span>Select</span></label>
<input type="radio" id="globalId">
```

Providing Labels using An Attribute

You can also initialize the label values using an attribute. This example uses an attribute to populate the radio button labels and wire them up to a client-side controller action when the radio button is selected or deselected.

```
<!--c:labelsAttribute-->
<aura:component>
    <aura:attribute name="stages" type="String[]" default="Any,Open,Closed,Closed,Closed
Won"/>
    <aura:iteration items="{#v.stages}" var="stage">
        <ui:inputRadio label="{#stage}" change="{!c.doSomething}"/>
    </aura:iteration>
</aura:component>
```

Note: `{#v.stages}` and `{#stage}` are unbound expressions. This means that any change to the value of the `items` attribute in `aura:iteration` or the `label` attribute in `ui:inputRadio` don't propagate back to affect the value of the `stages` attribute in `c:labelsAttribute`. For more information, see Data Binding Between Components on page 46.

Working with Events

Common events for `ui:inputRadio` include the `click` and `change` events. For example, `click="{!c.showItem}"` calls the client-side controller action with the fuction name, `showItem`.

The following code updates the CSS class of a component when the radio button is clicked.

```
<!--The radio button-->
    <ui:inputRadio click="{!c.showItem}" label="Show Item"/>
```

```
/* The controller action */
showItem : function(cmp, event) {
    var myCmp = cmp.find('myCmp');
    $A.util.toggleClass(myCmp, "cssClass");
}
```

SEE ALSO:

Handling Events with Client-Side Controllers
CSS in Components

Buttons

A button is clickable and actionable, providing a textual label, an image, or both. You can create a button in three different ways:

- Text-only Button

  ```
  <ui:button label="Find" />
  ```

- Image-only Button

  ```
  <ui:button iconImgSrc="/auraFW/resources/aura/images/search.png" label="Find"
  labelDisplay="false"/>
  ```

- Button with Text and Image

  ```
  <ui:button label="Find" iconImgSrc="/auraFW/resources/aura/images/search.png"/>
  ```

HTML Rendering

The markup for a button with text and image results in the following HTML.

```
<button class="button uiButton--default uiButton" accesskey type="button">
  <img class="icon bLeft" alt="Find" src="path/to/img">
  <span class="label bBody truncate" dir="ltr">Find</span>
</button>
```

Working with Click Events

The `press` event on the `ui:button` component is fired when the user clicks the button. In the following example, `press="{!c.getInput}"` calls the client-side controller action with the function name, `getInput`, which outputs the input text value.

```
<aura:component>
  <ui:inputText aura:id="name" label="Enter Name:" placeholder="Your Name" />
  <ui:button aura:id="button" label="Click me" press="{!c.getInput}"/>
  <ui:outputText aura:id="outName" value="" class="text"/>
</aura:component>
```

```
/* Client-side controller */
({
    getInput : function(cmp, evt) {
        var myName = cmp.find("name").get("v.value");
```

```
        var myText = cmp.find("outName");
        var greet = "Hi,  " + myName;
        myText.set("v.value", greet);
    }
```

Controlling Propagation

To control propagation of DOM events, use the `stopPropagation` attribute. This example toggles propagation on a `ui:button` component.

```
<aura:component>
  <aura:attribute name="propagation" type="Boolean" default="false"/>
  <div onclick="{!c.handleWrapperClick}">
    <ui:button press="{!c.handleClick}" stopPropagation="{!v.propagation}" label="Aura 
Button"/>
  </div><br/>
  Propagation status: {! v.propagation ? 'OFF' : 'ON'}<br/>
  <ui:button press="{!c.togglePropagation} label="Toggle Propagation"/>
</aura:component>
```

```
/* Client-side controller */
({
    handleClick: function(cmp, event, helper) {
        console.log(event);
    },
    handleWrapperClick: function(cmp, event, helper) {
        alert('Click propagated to wrapper');
    },
    togglePropagation: function(cmp, event, helper) {
        cmp.set('v.propagation', !cmp.get('v.propagation'));
    }
})
```

Styling Your Buttons

The `ui:button` component is customizable with regular CSS styling. In the CSS file of your component, add the following class selector.

```
.THIS.uiButton {
    margin-left: 20px;
}
```

Note that no space is added in the `.THIS.uiButton` selector if your button component is a top-level element.

To override the styling for all `ui:button` components in your app, in the CSS file of your app, add the following class selector.

```
.THIS .uiButton {
    margin-left: 20px;
}
```

SEE ALSO:

Handling Events with Client-Side Controllers

CSS in Components

Which Button Was Pressed?

Drop-down Lists

Drop-down lists display a dropdown menu with options you can select.

Both single and multiple selections are supported. You can create a drop-down list using `ui:inputSelect`, which inherits the behavior and events from `ui:input`.

Here are a few basic ways to set up a drop-down list.

For multiple selections, set the `multiple` attribute to `true`.

Single Selection

```
<ui:inputSelect>
        <ui:inputSelectOption text="Red"/>
        <ui:inputSelectOption text="Green" value="true"/>
        <ui:inputSelectOption text="Blue"/>
</ui:inputSelect>
```

Multiple Selection

```
<ui:inputSelect multiple="true">
    <ui:inputSelectOption text="All Primary" label="All Contacts"/>
    <ui:inputSelectOption text="All Primary" label="All Primary"/>
    <ui:inputSelectOption text="All Secondary" label="All Secondary"/>
</ui:inputSelect>
```

Each option is represented by `ui:inputSelectOption`. The default selected value is specified by `value="true"` on the option.

Note: `v.value` represents the option's HTML `selected` attribute, and `v.text` represents the option's HTML `value` attribute.

Generating Options with `aura:iteration`

You can use `aura:iteration` to iterate over a list of items to generate options. This example iterates over a list of items and conditionally renders the options.

```
<aura:attribute name="contacts" type="String[]" default="All Contacts,Others"/>
<ui:inputSelect>
    <aura:iteration items="{!v.contacts}" var="contact">
        <aura:if isTrue="{!contact == 'All Contacts'}">
            <ui:inputSelectOption text="{!contact}" label="{!contact}"/>
            <aura:set attribute="else">
```

```
                <ui:inputSelectOption text="All Primary" label="All Primary"/>
                <ui:inputSelectOption text="All Secondary" label="All Secondary"/>
            </aura:set>
        </aura:if>
    </aura:iteration>
</ui:inputSelect>
```

Generating Options Dynamically

Generate the options dynamically on component initialization.

```
<aura:component>
  <aura:handler name="init" value="{!this}" action="{!c.doInit}"/>
  <ui:inputSelect label="Select me:" class="dynamic" aura:id="InputSelectDynamic"/>
</aura:component>
```

The following client-side controller generates options using `v.options` on the `ui:inputSelect` component by creating the `opts` object with several parameters. `v.options` takes in the list of objects and converts them into list options. Although the sample code generates the options during initialization, the list of options can be modified anytime when you manipulate the list in `v.options`. The component automatically updates itself and rerenders with the new options.

```
({
    doInit : function(cmp) {
        var opts = [
            { class: "optionClass", label: "Option1", value: "opt1"},
            { class: "optionClass", label: "Option2", value: "opt2" },
            { class: "optionClass", label: "Option3", value: "opt3" }

        ];
        cmp.find("InputSelectDynamic").set("v.options", opts);
    }
})
```

Note: `class` is a reserved word that might not work with older versions of Internet Explorer. We recommend using `"class"` with double quotes.

The list options support these parameters.

Parameter	Type	Description
class	String	The CSS class for the option.
disabled	Boolean	Indicates whether the option is disabled.
label	String	The label of the option to display on the user interface.
selected	Boolean	Indicates whether the option is selected.
value	String	Required. The value of the option.

Using Options On Multiple Lists

If you're reusing the same set of options on multiple drop-down lists, use different attributes for each set of options. Otherwise, selecting a different option in one list also updates other list options bound to the same attribute.

```
<aura:attribute name="options1" type="String" />
<aura:attribute name="options2" type="String" />
<ui:inputSelect aura:id="Select1" label="Select1" options="{!v.options1}" />
<ui:inputSelect aura:id="Select2" label="Select2" options="{!v.options2}" />
```

Working with Events

Common events for `ui:inputSelect` include the `change` and `click` events. For example, `change="{!c.onSelectChange}"` calls the client-side controller action with the function name, `onSelectChange`, when a user changes a selection.

Styling Your Field-level Errors

The `ui:inputSelect` component is customizable with regular CSS styling. The following CSS sample adds a fixed width to the drop-down menu.

```
.THIS.uiInputSelect {
    width: 200px;
    height: 100px;
}
```

Alternatively, use the `class` attribute to specify your own CSS class.

SEE ALSO:

Handling Events with Client-Side Controllers
CSS in Components

Field-level Errors

Field-level errors are displayed when an input validation error occurs on the field. Input components in the `lightning` namespace display a default error message when an error condition is met. For input components in the `ui` namespace, the framework creates a default error component, `ui:inputDefaultError`, which provides basic events such as `click` and `mouseover`. See Validating Fields for more information.

Alternatively, you can use `ui:message` for field-level errors by toggling visibility of the message when an error condition is met. See Dynamically Showing or Hiding Markup for more information.

Working with Events

Common events for `ui:message` include the `click` and `mouseover` events. For example, `click="{!c.revalidate}"` calls the client-side controller action with the function name, `revalidate`, when a user clicks the error message.

SEE ALSO:

Handling Events with Client-Side Controllers
CSS in Components

Menus

A menu is a drop-down list with a trigger that controls its visibility. You must provide the trigger and list of menu items. The dropdown menu and its menu items are hidden by default. You can change this by setting the `visible` attribute on the `ui:menuList` component to `true`. The menu items are shown only when you click the `ui:menuTriggerLink` component.

This example creates a menu with several items.

```
<ui:menu>
    <ui:menuTriggerLink aura:id="trigger" label="Opportunity Status"/>
        <ui:menuList class="actionMenu" aura:id="actionMenu">
              <ui:actionMenuItem aura:id="item2" label="Open"
click="{!c.updateTriggerLabel}"/>
              <ui:actionMenuItem aura:id="item3" label="Closed"
click="{!c.updateTriggerLabel}"/>
              <ui:actionMenuItem aura:id="item4" label="Closed Won"
click="{!c.updateTriggerLabel}"/>
        </ui:menuList>
</ui:menu>
```

The following components are nested in `ui:menu`.

Component	Description
`ui:menu`	A drop-down list with a trigger that controls its visibility
`ui:menuList`	A list of menu items
`ui:actionMenuItem`	A menu item that triggers an action
`ui:checkboxMenuItem`	A menu item that supports multiple selection and can be used to trigger an action
`ui:radioMenuItem`	A menu item that supports single selection and can be used to trigger an action
`ui:menuItemSeparator`	A visual separator for menu items
`ui:menuItem`	An abstract and extensible component for menu items in a `ui:menuList` component
`ui:menuTrigger`	A trigger that expands and collapses a menu
`ui:menuTriggerLink`	A link that triggers a dropdown menu. This component extends `ui:menuTrigger`

Horizontal Layouts

`ui:block` provides a horizontal layout for your components. It extends `aura:component` and is an actionable component. It is useful for laying out your labels, fields, and buttons or any groups of components in a row.

Here is a basic set up of a horizontal layout. The following sample code creates a horizontal view of an image, text field, and a button. The `ui:inputText` component renders in between the `left` and `right` attributes.

```
<ui:block>
    <aura:set attribute="left">
```

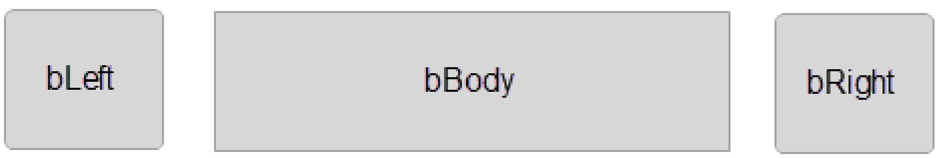
```
        <ui:image src="/auraFW/resources/aura/images/search.png" alt="bLeft" />
    </aura:set>
    <aura:set attribute="right">
        <ui:button label="Submit"/>
    </aura:set>
    <ui:inputText label="Text" labelPosition="hidden" />
</ui:block>
```

Working with Events

Common events for `ui:block` include the `click` and `mouseover` events. For example, `click="{!c.enable}"` calls the client-side controller action with the function name, `enable`, when a user clicks anywhere in the layout.

Styling Your Horizontal Layouts

`ui:block` is customizable with regular CSS styling. The output is rendered in `div` tags with the `bLeft`, `bRight`, and `bBody` classes.



The following CSS class styles the `bLeft` class on the `ui:block`.

```
.THIS.uiBlock .bLeft { //CSS declaration }
```

Alternatively, use the `class` attribute to specify your own CSS class.

SEE ALSO:

Handling Events with Client-Side Controllers

CSS in Components

Vertical Layouts

`ui:vbox` provides a vertical layout for your components. It extends `aura:component` and is an actionable component. It is useful for laying out groups of components vertically on a page.

Here is a basic set up of a vertical layout. The following sample code creates a vertical view of a header, body, and footer. The body of the component renders in between the `north` and `south` attributes.

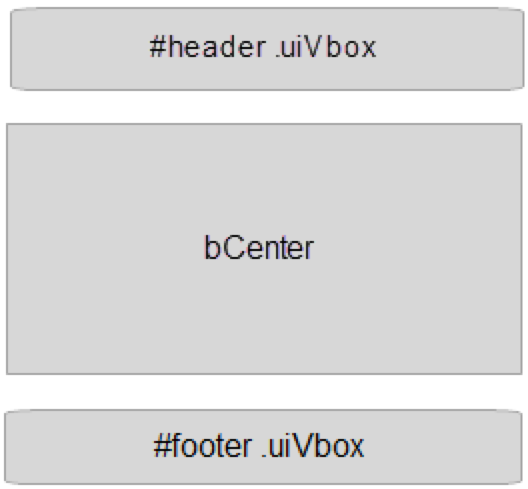
```
<ui:vbox>
    <aura:set attribute="north">
    <div id="header">Header</div>
    </aura:set>
    <aura:set attribute="south">
    <div id="footer">Footer</div>
    </aura:set>
    body
</ui:vbox>
```

Working with Events

Common events for `ui:vbox` include the `click` and `mouseover` events. For example, `click="{!c.enable}"` calls the client-side controller action with the fuction name, `enable`, when a user clicks anywhere in the layout.

Styling Your Vertical Layouts

`ui:vbox` is customizable with regular CSS styling. Given the above example, the output is rendered in `<div id="header" class="uiVbox">` and `<div id="footer" class="uiVbox">` tags, with the footer rendered in the bottom.



The following CSS class styles the `header` element in the `north` attribute.

```
.THIS #header { //CSS declaration }
```

SEE ALSO:

Handling Events with Client-Side Controllers

CSS in Components

Working with Auto-Complete

`ui:autocomplete` displays suggestions as users type in a text field. Data for this component is provided by a server-side model. This component provides its own text field and text area component. The default is a text field but you can change it to a text area by setting `inputType="inputTextArea"`.

Here is a basic set up of the auto-complete component with a default input text field.

```
<ui:autocomplete aura:id="autoComplete" optionVar="row"
    matchDone="{!c.handleMatchDone}"
    inputChange="{!c.handleInputChange}"
    selectListOption="{!c.handleSelectOption}">
    <aura:set attribute="dataProvider">
        <demo:dataProvider/>
    </aura:set>
    <aura:set attribute="listOption">
```

```
        <ui:autocompleteOption label="{!row.label}" keyword="{!row.keyword}"
                                value="{!row.value}" visible="{!row.visible}"/>
    </aura:set>
</ui:autocomplete>
```

Working with Events

Common events for `ui:autocomplete` include the `fetchData`, `inputChange`, `matchDone`, and `selectListOption` events. The behaviors for these events can be configured as desired.

`fetchData`

Fire the `fetchData` event if you want to fetch data through the data provider. For example, you can fire this event in the `inputChange` event when the input value changes. The `ui:autocomplete` component automatically matches text on the new data.

`inputChange`

Use the `inputChange` event to handle an input value change. Get the new value with `event.getParam("value")`. The following code handles a text match on existing data.

```
var matchEvt = acCmp.get("e.matchText");
matchEvt.setParams({
    keyword: event.getParam("value")
});
matchEvt.fire();
```

`matchDone`

Use the `matchDone` event to handle when a text matching has completed, regardless if a match has occurred. You can retrieve the number of matches with `event.getParam("size")`.

`selectListOption`

Use the `selectListOption` event to handle when a list option is selected. Get the options with `event.getParam("option");`. This event is fired by the `ui:autocompleteList` component when a list option is selected.

Providing Data to the Auto-complete Component

In the basic set up above, `demo:dataProvider` provides the list of data to be displayed as suggestions when a text match occurs. `demo:dataProvider` extends `ui:dataProvider` and takes in a server-side model.

The following code is a sample data provider for the `ui:autocomplete` component.

```
<aura:component extends="ui:dataProvider"
    model="java://org.auraframework.impl.java.model.TestJavaModel">
    <aura:attribute name="dataType" type="String"/>
</aura:component>
```

In the client-side controller or helper function of your data provider, fire the `onchange` event on the parent `ui:dataProvider` component. This event handles any data changes on the list.

```
var data = component.get("m.listOfData");
var dataProvider = component.getConcreteComponent();
//Fire the onchange event in the ui:dataProvider component
this.fireDataChangeEvent(dataProvider, data);
```

See the data provider at `aura/src/test/components/uitest/testAutocompleteDataProvider` in the GitHub repo.

To learn how the data provider is retrieving data from the model, see the server-side model at `/aura-impl/src/test/java/org/auraframework/impl/java/model/TestJavaModel.java` in the GitHub repo.

Styling Your Auto-complete Component

The `ui:autocomplete` component is customizable with regular CSS styling. For example, if you're using the default text field component provided by `ui:autocomplete`, you can use the following CSS selector.

```
.THIS.uiInputText {
    //CSS declaration
 }
```

If you're using the default text area component provided by `ui:autocomplete`, change the CSS selector to `.THIS.uiInputTextArea`. Alternatively, use the `class` attribute to specify your own CSS class.

SEE ALSO:

- Handling Events with Client-Side Controllers
- CSS in Components
- Client-Side Runtime Binding of Components

Creating Lists

You can create lists in three different ways, using `aura:iteration`, `ui:list`, or `ui:infiniteList`. `aura:iteration` is used for simple lists and can take in data from a model.

`ui:list` and `ui:infiniteList` provide a paging interface to navigate lists. `ui:list` can be used for more robust list implementations that retrieves and display more data as necessary, with a data provider and a template for each list item. Additionally, use `ui:infiniteList` if you want a robust list implementation similar to `ui:list`, but with a handler that enables you to retrieve and display more data when the user reaches the bottom of the list.

Here is a basic set up of the `ui:list` component with a required data provider and template.

```
<ui:list itemVar="item">
    <aura:set attribute="dataProvider">
        <auradev:testDataProvider />
    </aura:set>
    <aura:set attribute="header">
        Item List
    </aura:set>
    <aura:set attribute="itemTemplate">
        <auradocs:demoListTemplate label="{!item.label}" />
    </aura:set>
</ui:list>
```

`itemVar` is a required attribute that is used to iterate over the items provided by the item template. In the above example, `{!item.label}` iterates over the items provided by the data provider and displays the labels.

The sample template, `auradocs:demoListTemplate` is as follows. This template is a row of text generated by the data provider.

```
<aura:component>
  <aura:attribute name="label" type="String"/>
  <div class="row">
    {!v.label}
  </div>
</aura:component>
```

Working with List Events

`ui:list` and `ui:infiniteList` inherits from `ui:abstractList`. Common events for `ui:list` include user interface events like `click` events, and list-specific events like `refresh` and `triggerDataProvider`.

`refresh`

The `refresh` event handles a list data refresh and fires the `triggerDataProvider` event. You can fire the `refresh` event by using the following sample code in your client-side controller action.

```
var listData = cmp.find("listData");
listData.get("e.refresh").fire();
```

`showMore`

The `showMore` event in `ui:infiniteList` handles the fetching of your data and displays it. This event fires the `triggerDataProvider` event as well.

`triggerDataProvider`

The`triggerDataProvider` event triggers the providing of data from a data provider. It is also run during component initialization and refresh. For example, you can use this event if you want to retrieve more data in a `ui:infiniteList` component.

```
cmp.set("v.currentPage", targetPage);
var listData = component.find("listData");
listData.get("e.triggerDataProvider").fire();
```

Providing Data to the List Component

In the basic set up above, `auradocs:demoDataProvider` provides the list of data to the `ui:list` component. `auradocs:demoDataProvider` extends `ui:dataProvider` and takes in a server-side model.

The following code is the sample data provider, `auradocs:demoDataProvider`.

```
<aura:component extends="ui:dataProvider"
    model="java://org.auraframework.component.auradev.TestDataProviderModel"
    controller="java://org.auraframework.component.auradev.TestDataProviderController"
    description="A data provider for ui:list">
      <aura:handler name="provide" action="{!c.provide}"/>
</aura:component>
```

The `provide` event is fired on initialization by the parent `ui:abstractList` component. You can customize the `provide` event in your client-side controller. For example, the following code shows a sample `provide` helper function for a data provider.

```
var dataProvider = component.getConcreteComponent();
var action = dataProvider.get("c.getItems");

//Set the parameters for this action
action.setParams({
```

```
    "currentPage": dataProvider.get("v.currentPage"),
    "pageSize": dataProvider.get("v.pageSize")
    //Other ui:list or ui:infiniteList parameters
});

//Set the action callback
action.setCallback(this, function(response) {
    var state = response.getState();
    if (state === "SUCCESS") {
        var result = response.getReturnValue();
        this.fireDataChangeEvent(dataProvider, result);
    }
});
$A.enqueueAction(action);
```

Note: See the data provider at `aura-components/src/main/components/auradocs/demoDataProvider/` in the GitHub repo.

To learn how the data provider is retrieving data from the model, see the server-side model at `aura-impl/src/main/java/org/auraframework/component/auradev/TestDataProviderModel.java`.

Styling Your List Component

The `ui:list` component is customizable with regular CSS styling. For example, the sample template code above has `<div class="row">`. To apply CSS, you can use the following CSS selector in the template component.

```
.THIS .row{
    //CSS declaration
 }
```

SEE ALSO:

Handling Events with Client-Side Controllers

CSS in Components

Supporting Accessibility

Components are created with accessibility in mind. This is also true for components that extend these components.

When customizing components, be careful in preserving code that ensures accessibility, such as the `aria` attributes.

Accessible software and assistive technology enable users with disabilities to use and interact with the products you build. Aura components are created according to W3C specifications so that they work with common assistive technologies. While we always recommend that you follow the WCAG Guidelines for accessibility when developing with Aura, this guide explains the accessibility features that you can leverage when using components in the `ui` namespace.

In general, you can think of the components as either basic or complex, interactive components.

Basic Components

- `ui:image` — for images and icons
- `ui:input` — for input elements such as text fields and date fields
- `ui:button` — for input elements such as push buttons, radio buttons, and checkboxes

Complex, Interactive Components

- `ui:autocomplete` — for autocompleting dropdowns
- `ui:carousel` — for carousel interactions
- `ui:tabset` — for tab and tab panel interactions
- `ui:datePicker` — for calendar pickers
- `ui:panel` — for modal and non-modal overlays
- `ui:menu` — for menus, dropdowns, and muttons
- `ui:message` — for displaying page updates to users and updating screen readers

Accessibility Testing

To check that a component's HTML output is compliant with our accessibility validation, run `$A.test.assertAccessible()`. You can also run `$A.devToolService.checkAccessibility()` on a browser console. This tool checks the rendered DOM elements to make sure that they pass Salesforce's accessibility validation. Examples of this include image tags requiring an `alt` attribute, active panels correctly setting the `aria-hidden` attribute, and `input`, `select`, and `textarea` tags having associated labels.

When using the tool, there are two outcomes: pass or fail. If the tool does not find any accessibility exceptions, it returns an empty string. When the tool does find accessibility exceptions, it will include the accessibility rule that failed, the erroneous tag, and a stacktrace of where it was found in the code.

To use these tests, you must have the Aura Framework loaded. The tests can be used in the console (`$A.devToolService.checkAccessibility()`), JSTEST (`$A.test.assertAccessible()`), or in a WebDriver test (`auraTestingUtil.assertAccessible()`).

The tests look for these issues:

- Images without the `alt` attribute
- Anchor element without textual content
- `input` elements without an associated label
- Radio button groups not in a `fieldset` tag
- `iframe` or `frame` elements with empty `title` attribute
- `fieldset` element without a `legend`
- `th` element without a `scope` attribute
- `head` element with an empty `title` attribute
- Headings (`H1`, `H2`, etc.) increasing by more than one level at a time
- CSS color contrast ratio between text and background less than 4.5:1

Since Aura is a single page javascript application, the person writing the test will have to make sure to re-test when the DOM changes. The person using the tool should place a check after the DOM has changed to ensure greater accessibility validation coverage.

The sections below include more information specific to different types of components.

IN THIS SECTION:

Button Labels

Carousels

Help and Error Messages

Audio Messages

Forms, Fields, and Labels

Images

Events

Dialog Overlays

Menus

Resolving Accessibility Errors

Accessibility tests validate generated HTML markup and may return an error code followed by a message to help you resolve those errors.

Button Labels

Buttons can appear with text only, an icon and text, or an icon without text. To create an accessible button, use `lightning:button` and set a textual label using the `label` attribute.

Note: You can create accessible buttons using `ui:button` but they don't come with Lightning Design System styling. We recommend using `lightning:button` instead.

Button with text only:

```
<lightning:button label="Search" onclick="{!c.doSomething}"/>
```

Button with icon and text:

```
<lightning:button label="Download" iconName="utility:download" onclick="{!c.doSomething}"/>
```

Button with icon only:

```
<lightning:buttonIcon iconName="utility:settings" alternativeText="Settings"
onclick="{!c.doSomething}"/>
```

The `alternativeText` attribute provides a text label that's hidden from view and available to assistive technology.

This example shows the HTML generated by `lightning:button`:

```
<!-- Good: using span/assistiveText to hide the label visually, but show it to screen
readers -->
<button>
    ::before
    <span class="slds-assistive-text">Settings</span>
</button>
```

SEE ALSO:

Buttons

Carousels

The `ui:carousel` component displays a list of items horizontally where users can swipe through the list or click through the page indicators.

If your code failed, check to make sure the page indicators are visible. If `visible="false"` is set on the `ui:carouselPageIndicatorItem`, the page indicators will be hidden from view. Similarly, setting `continuousFlow="true"` on `ui:carousel` hides the page indicators from view.

Help and Error Messages

Use the `ariaDescribedby` attribute to associate the help text or error message with a particular field. Let's say you want to create help text for `ui:inputText`.

```
<ui:inputText label="Contact Name" ariaDescribedby="contact" />
<ui:outputText aura:id="contact" value="This is an example of a help text." />
```

Using the input component to create and handle the `ui:inputDefaultError` component automatically applies the `ariaDescribedby` attribute on the error messages. If you want to manually manage the action, you will need to make the connection between the `ui:inputDefaultError` component and the associated output.

Your component should render like this example:

```
<!-- Good: aria-describedby is used to associate error message -->
<label for="fname">Contact name</label>
<input name="" type="text" id="fname" aria-describedby="msgid">
<ul class="uiInputDefaultError" id="msgid">
    <li>Please enter the contact name</li>
</ul>
```

SEE ALSO:

Validating Fields

Audio Messages

To convey audio notifications, use the `ui:message` component, which has `role="alert"` set on the component by default. The `"alert"` `aria` role will take any text inside the div and read it out loud to screen readers without any additional action by the user.

```
<ui:message title="Error" severity="error" closable="true">
      This is an error message.
</ui:message>
```

Forms, Fields, and Labels

Input components are designed to make it easy to assign labels to form fields. Labels build a programmatic relationship between a form field and its textual label. You can assign a label in two ways. Use the `label` attribute on a component that extends `ui:input` or use the `ui:label` component and bind it to the corresponding input component. When using a placeholder in an input component, set the `label` attribute for accessibility.

Use `lightning:input` to create accessible input fields and forms. You can use `lightning:textarea` in preference to the `<textarea>` tag for multi-line text input or `lightning:select` instead of the `<select>` tag.

```
<lightning:input name="myInput" label="Search" />
```

Designs often include form elements with placeholder text, but no visible label. A label is required for accessibility and can be hidden visually. Set `variant="label-hidden"` to hide it from view but make the component accessible.

```
<lightning:input name="myInput" aura:id="myInput" value="Set your input value here."
variant="label-hidden"/>
```

If your code fails, check the label element during component rendering. A label element should have the `for` attribute and match the value of input control id attribute, OR the label should be wrapped around an input. Input controls include `<input>`, `<textarea>`, and `<select>`.

Here's an example of the HTML generated by `lightning:input`.

```
<!-- Good: using label/for= -->
<label for="fullname">Enter your full name:</label>
<input type="text" id="fullname" />

<!-- Good: --using implicit label>
<label>Enter your full name:
    <input type="text" id="fullname"/>
</label>
```

SEE ALSO:

Using Labels

Images

For an image to be accessible, set an appropriate alternative text attribute. If your image is informational, or actionable as part of a hyperlink, set the `alt` attribute to a descriptive alternative text. If the image is purely decorative, set `imageType="decorative"`. This generates a null `alt` attribute in the `img` tag.

```
<ui:image src="s.gif" imageType="informational" alt="Open Menu" />
```

```
<ui:image src="s.gif" imageType="decorative" />
```

When displaying an informational or actionable image via CSS, include the `assistiveText` class to provide an appropriate alternative text.

```
<a class="like">
    <span class="assistiveText">Like</span>
</a>
```

IN THIS SECTION:

Using Images

Using Images

To display images, use the `ui:image` component. The `ui:image` component automates common usages of the HTML `<img>` tag, such as `href` linking and other attributes. Additionally, include the `imageType` attribute to show if the image is informational or decorative. Use the `title` attribute for tooltips, especially for icons.

Informational Images

Informational images can provide information that may not be available in the text, such as a Like or Follow image. They are actionable and can stand alone in a button or hyperlink. Include the `alt` tag to specify alternate text for the image, which is helpful if the user has no access to the image.

```
<ui:image src="follow.png" imageType="informational" alt="follow" />
```

If you use CSS to display an informational image, you must provide assistive text that will be put into the DOM, by using the `assistiveText` class.

```
<div class="Following">
    <span class="assistiveText">Following</span>
</div>
```

Decorative Images

Decorative images are images that can be removed without affecting the logic or content of the page. You don't need to specify assistive text for decorative images.

```
<ui:image src="decoration.png" imageType="decorative" />
```

Code Samples

If your code failed, check to make sure you used the `alt` tag and the `assistiveText` class correctly.

Informational image code example:

```
alt tag:
<ui:image src="follow.png" imageType="informational" alt="follow" />
assistiveText class:
<div class="Following">
    <span class="assistiveText">Following</span>
</div>
```

Decorative image code example:

```
<ui:image src="decoration.png" imageType="decorative" />
```

Events

Although you can attach an `onclick` event to any type of element, for accessibility, consider only applying this event to elements that are actionable in HTML by default, such as `<a>`, `<button>`, or `<input>` tags in component markup. You can use an `onclick` event on a `<div>` tag to prevent event bubbling of a click.

Dialog Overlays

The `ui:panel` component creates an overlay that lets users access additional information without leaving the current page. Modal overlay requires the user to take an action or cancel the overlay to go back to the original page. Non-modal overlays offer useful information but can be ignored by users.

To create a modal overlay, use `panelType: 'modal'`, which locks keyboard focus inside the modal. `autoFocus` must be also true for the component to be accessible. `autoFocus` is true by default. To create a non-modal overlay, set `panelType: 'panel'` and users can just tab through. Fire the `ui:createPanel` event to create a modal or non-modal overlay.

```
$A.get('e.ui:createPanel').setParams({
    panelType: 'modal',
    visible: true,
    panelConfig: {
        title: 'Modal Header',
        autoFocus: true,
```

```
        body: body,
        footer: footer
        },
        onCreate: function(panel){
            //do something
        }
    }).fire();
```

`ui:panel` needs to have a title to meet accessibility standards, but it doesn't have to be visible. Use `titleDisplay: false` to hide the title, if desired.

Menus

A menu is a dropdown list with a trigger that controls its visibility. You must provide the trigger, which displays a text label, and a list of menu items. The dropdown menu and its menu items are hidden by default. You can change this by setting the `visible` attribute on the `ui:menuList` component to `true`. The menu items are shown only when you click the `ui:menuTriggerLink` component.

This example code creates a menu with several items:

```
<ui:menu>
    <ui:menuTriggerLink aura:id="trigger" label="Opportunity Status"/>
        <ui:menuList class="actionMenu" aura:id="actionMenu">
              <ui:actionMenuItem aura:id="item2" label="Open"
click="{!c.updateTriggerLabel}"/>
              <ui:actionMenuItem aura:id="item3" label="Closed"
click="{!c.updateTriggerLabel}"/>
              <ui:actionMenuItem aura:id="item4" label="Closed Won"
click="{!c.updateTriggerLabel}"/>
        </ui:menuList>
</ui:menu>
```

Different menus achieve different goals. Make sure you use the right menu for the desired behavior. The three types of menus are:

Actions
: Use the `ui:actionMenuItem` for items that create an action, like print, new, or save.

Radio button
: If you want users to pick only one from a list several items, use `ui:radioMenuItem`.

Checkbox style
: If users can pick multiple items from a list of several items, use `ui:checkboxMenuItem`. Checkboxes can also be used to turn one item on or off.

Note: To create a dropdown menu with a trigger that's a button, use `lightning:buttonMenu` instead.

Resolving Accessibility Errors

Accessibility tests validate generated HTML markup and may return an error code followed by a message to help you resolve those errors.

The following errors flag accessibility issues in your components. Resolve these errors to ensure that your components are accessible.

[A11Y_DOM_01] All image tags require the presence of the alt attribute

Informational images must have a description set on its `alt` attribute. If the image is decorative, set `alt=""`. For more information, see Images on page 101.

```
<!-- Informational image -->
<img src="admin.png" alt="admin image">
```

[A11Y_DOM_02] Labels are required for all input controls

A label element should have a `for` attribute and match the value of the `id` attribute on the input control, or the label should be wrapped around the input. Input controls include `<input>`, `<textarea>` and `<select>`. For more information, see Forms, Fields, and Labels on page 100.

```
<!-- Method 1: Use label/for -->
<label for="fullname">Enter your full name:</label>
<input type="text" id="fullname"/>

 <!-- Method 2: Use an implicit label-->
<label>Enter your full name:
    <input type="text" id="fullname"/>
</label>
```

[A11Y_DOM_03] Buttons must have non-empty text labels

When using `ui:button`, assign a non-empty string to the `label` attribute. For an icon-only button, use `labelDisplay` in `ui:button` to hide the label text. For more information, see Button Labels on page 99.

```
<!-- Method 1: Use the alt attribute to provide a hidden label -->
<button>
    <img src="enter_site.gif" alt="enter site"/>
</button>

<!-- Method 2: Use a span tag with assistiveText class to hide the label visually -->
<button>
    <span class="assistiveText">Enter site</span>
</button>
```

[A11Y_DOM_04] Links must have non-empty text content

For a graphical link, use a `ui:image` instead. To include hidden link text, use a `span` tag with `assistiveText` class. For buttons, use the `ui:button` component.

```
<!-- Method 1: Use an img tag with the alt attribute to provide link text  -->
<a href="routes.html">
    <img src="routes.png" alt="current routes" />
</a>

<!-- Method 2: Use a span tag with assistiveText class to provide link text -->
<a href="javascript:void(0);">
    <span class="assistiveText">Toggle Notifications</span>
    <div class="notificationCounter"></div>
</a>
```

[A11Y_DOM_05] Text color contrast ratio must meet the minimum requirement

Small text must have a contrast ratio of not less than 4.5:1. Small text includes those whose font size are:

- Smaller than 19px bold or semibold
- Smaller than 24px normal

Large text must have a contrast ratio of not less than 3.0:1. Large text includes those whose font size are:

- At least 19px bold or semibold
- At least 24px normal

A good color contrast ratio means that the foreground and background color provides enough contrast when viewed by a user who might have impaired vision or when viewed on a black and white screen. You can install Accessibility Developer Tools on your Google Chrome browser or use the WebAim Color Contrast Checker tool.

[A11Y_DOM_06] Each frame and iframe element must have a non-empty title attribute

If using an `iframe` element, include a descriptive `title` attribute.

```
<iframe src="banner-ad.html" id="testiframe" name="testiframe" title="Advertisement">
    <a href="banner-ad.html">Advertisement</a>
</iframe>
```

[A11Y_DOM_07] The head section must have a non-empty title element

In the `head` element, include a descriptive `title` tag.

```
<head>
    <title>Welcome</title>
</head>
```

[A11Y_DOM_08] Data table cells must be associated with data table headers

Use the `scope` attribute or use both the `id` and `header` attributes.

```
<!-- Method 1: Use the scope attribute -->
<table border="1"><caption>Contact Information</caption>
    <tr>
        <th scope="col">Name</th>
        <th scope="col">Department</th>
    </tr>
    <tr>
        <td>admin</td>
        <td>R&D</td>
    </tr>
</table>

<!-- Method 2: Use the id and headers attributes -->
<table border="1">
    <tr>
        <th id="e1">First Name</th>
        <th id="e2">Last Name</th>
        <th id="e3">Department</th>
    </tr>
    <tr>
        <td headers="e1">John</td>
        <td headers="e2">Smith</td>
        <td headers="e3">R&D</td>
    </tr>
</table>
```

[A11Y_DOM_09] Fieldset must have a legend element

Include a descriptive legend in your `fieldset` element.

```
<fieldset>
    <legend>Choose yes or no</legend>
</fieldset>
```

[A11Y_DOM_10] Related radio buttons or checkboxes must be grouped with a fieldset

Nest your radio buttons and checkboxes in a `fieldset` tag.

```
<fieldset>
    <legend>Choose yes or no</legend>
    <input type="radio" name="yes" id="yesid" value="yes"/>
    <label for="yesid">yes</label>
    <input type="radio" name="no" id="noid" value="no"/>
    <label for="noid">no</label>
</fieldset>
```

[A11Y_DOM_11] Headings should be properly nested

Headings should increase no more than one level each time, and can start at any level.

```
<h2>Profile</h2>
<h3>Profile Details</h3>
<h2>Interests</h2>
```

[A11Y_DOM_12] Base and top panels should have proper aria-hidden properties

The `aria-hidden` attribute indicates whether an element is hidden or not, and can be set to `true` or `false` respectively.

```
<!-- aria-hidden of base panel is false if top panel is not active -->
<section class="stage panelSlide forceAccess" aria-hidden="false"></div>
<div class="panel panelOverlay" aria-hidden="true"></div>

<!-- aria-hidden of base panel is true if there is active top panel -->
<section class="stage panelSlide forceAccess" aria-hidden="true"></div>
<div class="panel panelOverlay active" aria-hidden="false"></div>
```

[A11Y_DOM_13] Aria-describedby must be used to associate error message with input control

The `aria-describedby` attribute indicates the IDs of the elements that describe the object, and can be used to associate static text with groups of elements. For more information, see Help and Error Messages on page 100.

```
<label for="fname">First name</label>
<input name="firstname" type="text" id="fname" aria-describedby="msgid">
<ul class="uiInputDefaultError" id="msgid">
```

[A11Y_DOM_14] Button must not have duplicate values

Text values in buttons should be unique.

```
<!-- Example 1 -->
<button>
    <span class="assistiveText">My help text</span>
    My other text
</button>

<!-- Example 2 -->
<button>
    My text
```

```
    <img src="icon.gif" alt="My other text">
</button>
```

[A11Y_DOM_15] A label was found without an associated input. Labels should only be used to identify inputs.

Each label should be associated to one input only. Check that you're not accidentally creating two labels for an input. For example, if you're using `ui:label` to create a label for a `ui:inputText` component, don't use the `label` and `labelDisplay="false"` attributes on the component. You should only use `labelDisplay="false"` if your input doesn't have a visible label. For more information, see Forms, Fields, and Labels.

Add Components to Apps

When you're ready to add components to your app, you should first look at the out-of-the-box components that come with the framework. You can also leverage these components by extending them or using composition to add them to custom components that you're building.

Note: See the `Components` folder in the Reference tab for all the out-of-the-box components. The `ui` namespace includes many components that are common on Web pages.

Components are encapsulated and their internals stay private, while their public shape is visible to consumers of the component. This strong separation gives component authors freedom to change the internal implementation details and insulates component consumers from those changes.

The public shape of a component is defined by the attributes that can be set and the events that interact with the component. The shape is essentially the API for developers to interact with the component. To design a new component, think about the attributes that you want to expose and the events that the component should initiate or respond to.

Once you have defined the shape of any new components, developers can work on the components in parallel. This is a useful approach if you have a team working on an app.

SEE ALSO:

Component Composition

Using Object-Oriented Development

Component Attributes

Communicating with Events

CHAPTER 4 Communicating with Events

In this chapter ...

The framework uses event-driven programming. You write handlers that respond to interface events as they occur. The events may or may not have been triggered by user interaction.

In Aura, events are fired from JavaScript controller actions. Events can contain attributes that can be set before the event is fired and read when the event is handled.

Events are declared by the `aura:event` tag in a `.evt` file, and they can have one of two types: component or application.

Component Events

A component event is fired from an instance of a component. A component event can be handled by the component that fired the event or by a component in the containment hierarchy that receives the event.

Application Events

Application events follow a traditional publish-subscribe model. An application event is fired from an instance of a component. All components that provide a handler for the event are notified.

Note: Always try to use a component event instead of an application event, if possible. Component events can only be handled by components above them in the containment hierarchy so their usage is more localized to the components that need to know about them. Application events are best used for something that should be handled at the application level, such as navigating to a specific record. Application events allow communication between components that are in separate parts of the application and have no direct containment relationship.

Actions and Events

The framework uses events to communicate data between components. Events are usually triggered by a user action.

Actions

User interaction with an element on a component or app. User actions trigger events, but events aren't always explicitly triggered by user actions. This type of action is *not* the same as a client-side JavaScript controller, which is sometimes known as a *controller action*. The following button is wired up to a browser `onclick` event in response to a button click.

```
<lightning:button label = "Click Me" onclick = "{!c.handleClick}" />
```

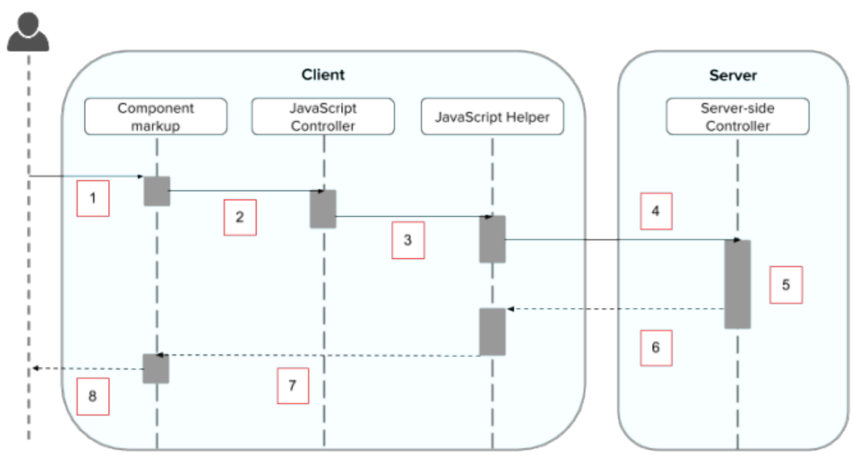
Clicking the button invokes the `handleClick` method in the component's client-side controller.

Events

A notification by the browser regarding an action. Browser events are handled by client-side JavaScript controllers, as shown in the previous example. A browser event is not the same as a framework *component event* or *application event*, which you can create and fire in a JavaScript controller to communicate data between components. For example, you can wire up the click event of a checkbox to a client-side controller, which fires a component event to communicate relevant data to a parent component.

Another type of event, known as a *system event*, is fired automatically by the framework during its lifecycle, such as during component initialization, change of an attribute value, and rendering. Components can handle a system event by registering the event in the component markup.

The following diagram describes what happens when a user clicks a button that requires the component to retrieve data from the server.



1. User clicks a button or interacts with a component, triggering a browser event. For example, you want to save data from the server when the button is clicked.
2. The button click invokes a client-side JavaScript controller, which provides some custom logic before invoking a helper function.
3. The JavaScript controller invokes a helper function. A helper function improves code reuse but it's optional for this example.
4. The helper function calls a server-side controller method and queues the action.
5. The server-side method is invoked and data is returned.
6. A JavaScript callback function is invoked when the server-sideApex method completes.
7. The JavaScript callback function evaluates logic and updates the component's UI.

8. User sees the updated component.

SEE ALSO:

Handling Events with Client-Side Controllers
Detecting Data Changes with Change Handlers
Calling a Server-Side Action
Events Fired During the Rendering Lifecycle

Handling Events with Client-Side Controllers

A client-side controller handles events within a component. It's a JavaScript file that defines the functions for all of the component's actions.

A client-side controller is a JavaScript object in object-literal notation containing a map of name-value pairs. Each name corresponds to a client-side action. Its value is the function code associated with the action. Client-side controllers are surrounded by parentheses and curly braces. Separate action handlers with commas (as you would with any JavaScript map).

```
({
    myAction : function(cmp, event, helper) {
        // add code for the action
    },

    anotherAction : function(cmp, event, helper) {
        // add code for the action
    }
})
```

Each action function takes in three parameters:

1. `cmp`—The component to which the controller belongs.
2. `event`—The event that the action is handling.
3. `helper`—The component's helper, which is optional. A helper contains functions that can be reused by any JavaScript code in the component bundle.

Creating a Client-Side Controller

A client-side controller is part of the component bundle. It is auto-wired via the naming convention, *`componentName`*`Controller.js`.

To reuse a client-side controller from another component, use the `controller` system attribute in `aura:component`. For example, this component uses the auto-wired client-side controller for `c.sampleComponent` in `c/sampleComponent/sampleComponentController.js`.

```
<aura:component
    controller="js://c.sampleComponent">
    ...
</aura:component>
```

Calling Client-Side Controller Actions

The following example component creates two buttons to contrast an HTML button with `<lightning:button>`, which is a standard Aura component. Clicking on these buttons updates the `text` component attribute with the specified values. `target.get("v.label")` refers to the `label` attribute value on the button.

Component source

```
<aura:component>
    <aura:attribute name="text" type="String" default="Just a string. Waiting for change."/>

    <input type="button" value="Flawed HTML Button"
        onclick="alert('this will not work')"/>
    <br/>
    <lightning:button label="Framework Button" onclick="{!c.handleClick}"/>
    <br/>
    {!v.text}
</aura:component>
```

If you know some JavaScript, you might be tempted to write something like the first "Flawed" button because you know that HTML tags are first-class citizens in the framework. However, the "Flawed" button won't work because arbitrary JavaScript, such as the `alert()` call, in the component is ignored.

The framework has its own event system. DOM events are mapped to Aura events, since HTML tags are mapped to Aura components.

Any browser DOM element event starting with `on`, such as `onclick` or `onkeypress`, can be wired to a controller action. You can only wire browser events to controller actions.

The "Framework" button wires the `onclick` attribute in the `<lightning:button>` component to the `handleClick` action in the controller.

Client-side controller source

```
({
    handleClick : function(cmp, event) {
        var attributeValue = cmp.get("v.text");
        console.log("current text: " + attributeValue);

        var target = event.getSource();
        cmp.set("v.text", target.get("v.label"));
    }
})
```

The `handleClick` action uses `event.getSource()` to get the source component that fired this component event. In this case, the source component is the `<lightning:button>` in the markup.

The code then sets the value of the `text` component attribute to the value of the button's `label` attribute. The `text` component attribute is defined in the `<aura:attribute>` tag in the markup.

Tip: Use unique names for client-side and server-side actions in a component. A JavaScript function (client-side action) with the same name as a Java method (server-side action) can lead to hard-to-debug issues. In PRODDEBUG mode, the framework logs a browser console warning about the clashing client-side and server-side action names.

Handling Framework Events

Handle framework events using actions in client-side component controllers. Framework events for common mouse and keyboard interactions are available with out-of-the-box components. For example, if you use the `lightning:input` component, you have access to its events, such as `onfocus` and `onblur`.

Accessing Component Attributes

In the `handleClick` function, notice that the first argument to every action is the component to which the controller belongs. One of the most common things you'll want to do with this component is look at and change its attribute values.

`cmp.get("v.attributeName")` returns the value of the ***attributeName*** attribute.

`cmp.set("v.attributeName", "attribute value")` sets the value of the ***attributeName*** attribute.

Invoking Another Action in the Controller

To call an action method from another method, put the common code in a helper function and invoke it using `helper.someFunction(cmp)`.

SEE ALSO:

Sharing JavaScript Code in a Component Bundle
Event Handling Lifecycle
Creating Server-Side Logic with Controllers

Component Events

A component event is fired from an instance of a component. A component event can be handled by the component that fired the event or by a component in the containment hierarchy that receives the event.

Note: To communicate from a parent component to a child component that it contains, use `<aura:method>` to call a method in the child component's client-side controller from the parent component. Using `<aura:method>` is easier than getting an instance of the child component in the parent component, and then firing and handling a component event.

When a component contains another component, we refer in the documentation to parent and child components in the containment hierarchy. When a component extends another component, we refer to sub and super components in the inheritance hierarchy.

IN THIS SECTION:

Fire Component Events

Fire a component event to communicate data to another component. A component event can be handled by the component that fired the event or by a component in the containment hierarchy that receives the event.

Handling Component Events

A component event can be handled by the component that fired the event or by a component in the containment hierarchy that receives the event.

SEE ALSO:

aura:method

Application Events

Handling Events with Client-Side Controllers

Advanced Events Example

What is Inherited?

Component Event Propagation

The framework supports *capture* and *bubble* phases for the propagation of component events. These phases are similar to DOM handling patterns and provide an opportunity for interested components to interact with an event and potentially control the behavior for subsequent handlers.

The component that fires an event is known as the source component. The framework allows you to handle the event in different phases. These phases give you flexibility for how to best process the event for your application.

The phases are:

Capture

The event is captured and trickles down from the application root to the source component. The event can be handled by a component in the containment hierarchy that receives the captured event.

Event handlers are invoked in order from the application root down to the source component that fired the event.

Any registered handler in this phase can stop the event from propagating, at which point no more handlers are called in this phase or the bubble phase.

Bubble

The component that fired the event can handle it. The event then bubbles up from the source component to the application root. The event can be handled by a component in the containment hierarchy that receives the bubbled event.

Event handlers are invoked in order from the source component that fired the event up to the application root.

Any registered handler in this phase can stop the event from propagating, at which point no more handlers are called in this phase.

Here's the sequence of component event propagation.

1. **Event fired**—A component event is fired.
2. **Capture phase**—The framework executes the capture phase from the application root to the source component until all components are traversed. Any handling event can stop propagation by calling `stopPropagation()` on the event.
3. **Bubble phase**—The framework executes the bubble phase from the source component to the application root until all components are traversed or `stopPropagation()` is called.

Note: Application events have a separate default phase. There's no separate default phase for component events. The default phase is the bubble phase.

Create Custom Component Events

Create a custom component event using the <aura:event> tag in a .evt resource. Events can contain attributes that can be set before the event is fired and read when the event is handled.

Use type="COMPONENT" in the <aura:event> tag for a component event. For example, this c:compEvent component event has one attribute with a name of message.

```
<!--c:compEvent-->
<aura:event type="COMPONENT">
    <!-- Add aura:attribute tags to define event shape.
         One sample attribute here. -->
    <aura:attribute name="message" type="String"/>
</aura:event>
```

The component that fires an event can set the event's data. To set the attribute values, call event.setParam() or event.setParams(). A parameter name set in the event must match the name attribute of an <aura:attribute> in the event. For example, if you fire c:compEvent, you could use:

```
event.setParam("message", "event message here");
```

The component that handles an event can retrieve the event data. To retrieve the attribute value in this event, call event.getParam("message") in the handler's client-side controller.

Fire Component Events

Fire a component event to communicate data to another component. A component event can be handled by the component that fired the event or by a component in the containment hierarchy that receives the event.

Register an Event

A component registers that it may fire an event by using <aura:registerEvent> in its markup. For example:

```
<aura:registerEvent name="sampleComponentEvent" type="c:compEvent"/>
```

We'll see how the value of the name attribute is used for firing and handling events.

Fire an Event

To get a reference to a component event in JavaScript, use cmp.getEvent("evtName") where evtName matches the name attribute in <aura:registerEvent>.

Use fire() to fire the event from an instance of a component. For example, in an action function in a client-side controller:

```
var compEvent = cmp.getEvent("sampleComponentEvent");
// Optional: set some data for the event (also known as event shape)
// A parameter's name must match the name attribute
// of one of the event's <aura:attribute> tags
// compEvent.setParams({"myParam" : myValue });
compEvent.fire();
```

SEE ALSO:

Fire Application Events

Handling Component Events

A component event can be handled by the component that fired the event or by a component in the containment hierarchy that receives the event.

Use `<aura:handler>` in the markup of the handler component. For example:

```
<aura:handler name="sampleComponentEvent" event="c:compEvent"
    action="{!c.handleComponentEvent}"/>
```

The `name` attribute in `<aura:handler>` must match the `name` attribute in the `<aura:registerEvent>` tag in the component that fires the event.

The `action` attribute of `<aura:handler>` sets the client-side controller action to handle the event.

The `event` attribute specifies the event being handled. The format is ***namespace*:*eventName***.

In this example, when the event is fired, the `handleComponentEvent` client-side controller action is called.

Event Handling Phases

Component event handlers are associated with the bubble phase by default. To add a handler for the capture phase instead, use the `phase` attribute.

```
<aura:handler name="sampleComponentEvent" event="ns:eventName"
    action="{!c.handleComponentEvent}" phase="capture" />
```

Get the Source of an Event

In the client-side controller action for an `<aura:handler>` tag, use `evt.getSource()` to find out which component fired the event, where `evt` is a reference to the event. To retrieve the source element, use `evt.getSource().getElement()`.

IN THIS SECTION:

Component Handling Its Own Event

A component can handle its own event by using the `<aura:handler>` tag in its markup.

Handle Component Event of Instantiated Component

A parent component can set a handler action when it instantiates a child component in its markup.

Handling Bubbled or Captured Component Events

Event propagation rules determine which components in the containment hierarchy can handle events by default in the bubble or capture phases. Learn about the rules and how to handle events in the bubble or capture phases.

Handling Component Events Dynamically

A component can have its handler bound dynamically via JavaScript. This is useful if a component is created in JavaScript on the client-side.

SEE ALSO:

Component Event Propagation

Handling Application Events

Component Handling Its Own Event

A component can handle its own event by using the `<aura:handler>` tag in its markup.

The `action` attribute of `<aura:handler>` sets the client-side controller action to handle the event. For example:

```
<aura:registerEvent name="sampleComponentEvent" type="c:compEvent"/>
<aura:handler name="sampleComponentEvent" event="c:compEvent"
    action="{!c.handleSampleEvent}"/>
```

Note: The `name` attributes in `<aura:registerEvent>` and `<aura:handler>` must match, since each event is defined by its name.

SEE ALSO:

Handle Component Event of Instantiated Component

Handle Component Event of Instantiated Component

A parent component can set a handler action when it instantiates a child component in its markup.

Let's a look at an example. `c:child` registers that it may fire a `sampleComponentEvent` event by using `<aura:registerEvent>` in its markup.

```
<!-- c:child -->
<aura:component>
    <aura:registerEvent name="sampleComponentEvent" type="c:compEvent"/>
</aura:component>
```

`c:parent` sets a handler for this event when it instantiates `c:child` in its markup.

```
<!-- parent.cmp -->
<aura:component>
    <c:child sampleComponentEvent="{!c.handleChildEvent}"/>
</aura:component>
```

Note how `c:parent` uses the following syntax to set a handler for the `sampleComponentEvent` event fired by `c:child`.

```
<c:child sampleComponentEvent="{!c.handleChildEvent}"/>
```

The syntax looks similar to how you set an attribute called `sampleComponentEvent`. However, in this case, `sampleComponentEvent` isn't an attribute. `sampleComponentEvent` matches the event name declared in `c:child`.

```
<aura:registerEvent name="sampleComponentEvent" type="c:compEvent"/>
```

The preceding syntax is a convenient shortcut for the normal way that a component declares a handler for an event. The parent component can only use this syntax to handle events from a direct descendent. If you want to be more explicit in `c:parent` that you're handling an event, or if the event might be fired by a component further down the component hierarchy, use an `<aura:handler>` tag instead of declaring the handler within the `<c:child>` tag.

```
<!-- parent.cmp -->
<aura:component>
    <aura:handler name="sampleComponentEvent" event="c:compEvent"
      action="{!c.handleSampleEvent}"/>
    <c:child />
</aura:component>
```

The two versions of `c:parent` markup behave the same. However, using `<aura:handler>` makes it more obvious that you're handling a `sampleComponentEvent` event.

SEE ALSO:

Component Handling Its Own Event
Handling Bubbled or Captured Component Events

Handling Bubbled or Captured Component Events

Event propagation rules determine which components in the containment hierarchy can handle events by default in the bubble or capture phases. Learn about the rules and how to handle events in the bubble or capture phases.

The framework supports *capture* and *bubble* phases for the propagation of component events. These phases are similar to DOM handling patterns and provide an opportunity for interested components to interact with an event and potentially control the behavior for subsequent handlers. The capture phase executes before the bubble phase.

Default Event Propagation Rules

By default, every parent in the containment hierarchy can't handle an event during the capture and bubble phases. Instead, the event propagates to every owner in the containment hierarchy.

A component's owner is the component that is responsible for its creation. For declaratively created components, the owner is the outermost component containing the markup that references the component firing the event. For programmatically created components, the owner component is the component that invoked `$A.createComponent` to create it.

The same rules apply for the capture phase, although the direction of event propagation (down) is the opposite of the bubble phase (up).

Confused? It makes more sense when you look at an example in the bubbling phase.

`c:owner` contains `c:container`, which in turn contains `c:eventSource`.

```
<!--c:owner-->
<aura:component>
    <c:container>
        <c:eventSource />
    </c:container>
</aura:component>
```

If `c:eventSource` fires an event, it can handle the event itself. The event then bubbles up the containment hierarchy.

`c:container` contains `c:eventSource` but it's not the owner because it's not the outermost component in the markup, so it can't handle the bubbled event.

`c:owner` is the owner because `c:container` is in its markup. `c:owner` can handle the event.

Propagation to All Container Components

The default behavior doesn't allow an event to be handled by every parent in the containment hierarchy. Some components contain other components but aren't the owner of those components. These components are known as container components. In the example, `c:container` is a container component because it's not the owner for `c:eventSource`. By default, `c:container` can't handle events fired by `c:eventSource`.

A container component has a facet attribute whose type is Aura.Component[], such as the default body attribute. The container component includes those components in its definition using an expression, such as {!v.body}. The container component isn't the owner of the components rendered with that expression.

To allow a container component to handle the event, add includeFacets="true" to the <aura:handler> tag of the container component. For example, adding includeFacets="true" to the handler in the container component, c:container, enables it to handle the component event bubbled from c:eventSource.

```
<aura:handler name="bubblingEvent" event="c:compEvent" action="{!c.handleBubbling}"
    includeFacets="true" />
```

Handle Bubbled Event

A component that fires a component event registers that it fires the event by using the <aura:registerEvent> tag.

```
<aura:component>
    <aura:registerEvent name="compEvent" type="c:compEvent" />
</aura:component>
```

A component handling the event in the bubble phase uses the <aura:handler> tag to assign a handling action in its client-side controller.

```
<aura:component>
    <aura:handler name="compEvent" event="c:compEvent" action="{!c.handleBubbling}"/>
</aura:component>
```

Note: The name attribute in <aura:handler> must match the name attribute in the <aura:registerEvent> tag in the component that fires the event.

Handle Captured Event

A component handling the event in the capture phase uses the <aura:handler> tag to assign a handling action in its client-side controller.

```
<aura:component>
    <aura:handler name="compEvent" event="c:compEvent" action="{!c.handleCapture}"
        phase="capture" />
</aura:component>
```

The default handling phase for component events is bubble if no phase attribute is set.

Stop Event Propagation

Use the stopPropagation() method in the Event object to stop the event propagating to other components.

Pausing Event Propagation for Asynchronous Code Execution

Use event.pause() to pause event handling and propagation until event.resume() is called. This flow-control mechanism is useful for any decision that depends on the response from the execution of asynchronous code. For example, you might make a decision about event propagation based on the response from an asynchronous call to native mobile code.

You can call pause() or resume() in the capture or bubble phases.

Event Bubbling Example

Let's look at an example so you can play around with it yourself.

```
<!--c:eventBubblingParent-->
<aura:component>
    <c:eventBubblingChild>
        <c:eventBubblingGrandchild />
    </c:eventBubblingChild>
</aura:component>
```

First, we define a simple component event.

```
<!--c:compEvent-->
<aura:event type="COMPONENT">
    <!--simple event with no attributes-->
</aura:event>
```

`c:eventBubblingEmitter` is the component that fires `c:compEvent`.

```
<!--c:eventBubblingEmitter-->
<aura:component>
    <aura:registerEvent name="bubblingEvent" type="c:compEvent" />
    <lightning:button onclick="{!c.fireEvent}" label="Start Bubbling"/>
</aura:component>
```

Here's the controller for `c:eventBubblingEmitter`. When you press the button, it fires the `bubblingEvent` event registered in the markup.

```
/*eventBubblingEmitterController.js*/
{
    fireEvent : function(cmp) {
        var cmpEvent = cmp.getEvent("bubblingEvent");
        cmpEvent.fire();
    }
}
```

`c:eventBubblingGrandchild` contains `c:eventBubblingEmitter` and uses `<aura:handler>` to assign a handler for the event.

```
<!--c:eventBubblingGrandchild-->
<aura:component>
    <aura:handler name="bubblingEvent" event="c:compEvent" action="{!c.handleBubbling}"/>


    <div class="grandchild">
        <c:eventBubblingEmitter />
    </div>
</aura:component>
```

Here's the controller for `c:eventBubblingGrandchild`.

```
/*eventBubblingGrandchildController.js*/
{
    handleBubbling : function(component, event) {
        console.log("Grandchild handler for " + event.getName());
```

```
    }
}
```

The controller logs the event name when the handler is called.

Here's the markup for `c:eventBubblingChild`. We will pass `c:eventBubblingGrandchild` in as the body of `c:eventBubblingChild` when we create `c:eventBubblingParent` later in this example.

```
<!--c:eventBubblingChild-->
<aura:component>
    <aura:handler name="bubblingEvent" event="c:compEvent" action="{!c.handleBubbling}"/>


    <div class="child">
        {!v.body}
    </div>
</aura:component>
```

Here's the controller for `c:eventBubblingChild`.

```
/*eventBubblingChildController.js*/
{
    handleBubbling : function(component, event) {
        console.log("Child handler for " + event.getName());
    }
}
```

`c:eventBubblingParent` contains `c:eventBubblingChild`, which in turn contains `c:eventBubblingGrandchild`.

```
<!--c:eventBubblingParent-->
<aura:component>
    <aura:handler name="bubblingEvent" event="c:compEvent" action="{!c.handleBubbling}"/>


    <div class="parent">
        <c:eventBubblingChild>
            <c:eventBubblingGrandchild />
        </c:eventBubblingChild>
    </div>
</aura:component>
```

Here's the controller for `c:eventBubblingParent`.

```
/*eventBubblingParentController.js*/
{
    handleBubbling : function(component, event) {
        console.log("Parent handler for " + event.getName());
    }
}
```

Now, let's see what happens when you run the code.

1. In your browser, navigate to `c:eventBubblingParent`.
2. Click the **Start Bubbling** button that is part of the markup in `c:eventBubblingEmitter`.

3. Note the output in your browser's console:

```
Grandchild handler for bubblingEvent
Parent handler for bubblingEvent
```

The `c:compEvent` event is bubbled to `c:eventBubblingGrandchild` and `c:eventBubblingParent` as they are owners in the containment hierarchy. The event is not handled by `c:eventBubblingChild` as `c:eventBubblingChild` is in the markup for `c:eventBubblingParent` but it's not an owner as it's not the outermost component in that markup.

Now, let's see how to stop event propagation. Edit the controller for `c:eventBubblingGrandchild` to stop propagation.

```
/*eventBubblingGrandchildController.js*/
{
    handleBubbling : function(component, event) {
        console.log("Grandchild handler for " + event.getName());
        event.stopPropagation();
    }
}
```

Now, navigate to `c:eventBubblingParent` and click the **Start Bubbling** button.

Note the output in your browser's console:

```
Grandchild handler for bubblingEvent
```

The event no longer bubbles up to the `c:eventBubblingParent` component.

SEE ALSO:

Component Event Propagation

Handle Component Event of Instantiated Component

Handling Component Events Dynamically

A component can have its handler bound dynamically via JavaScript. This is useful if a component is created in JavaScript on the client-side.

For more information, see Dynamically Adding Event Handlers To a Component on page 200.

Component Event Example

Here's a simple use case of using a component event to update an attribute in another component.

1. A user clicks a button in the notifier component, `ceNotifier.cmp`.
2. The client-side controller for `ceNotifier.cmp` sets a message in a component event and fires the event.
3. The handler component, `ceHandler.cmp`, contains the notifier component, and handles the fired event.
4. The client-side controller for `ceHandler.cmp` sets an attribute in `ceHandler.cmp` based on the data sent in the event.

Component Event

The `ceEvent.evt` component event has one attribute. We'll use this attribute to pass some data in the event when it's fired.

```
<!--c:ceEvent-->
<aura:event type="COMPONENT">
```

```
    <aura:attribute name="message" type="String"/>
</aura:event>
```

Notifier Component

The `c:ceNotifier` component uses `aura:registerEvent` to declare that it may fire the component event.

The button in the component contains an `onclick` browser event that is wired to the `fireComponentEvent` action in the client-side controller. The action is invoked when you click the button.

```
<!--c:ceNotifier-->
<aura:component>
    <aura:registerEvent name="cmpEvent" type="c:ceEvent"/>

    <h1>Simple Component Event Sample</h1>
    <p><lightning:button
        label="Click here to fire a component event"
        onclick="{!c.fireComponentEvent}" />
    </p>
</aura:component>
```

The client-side controller gets an instance of the event by calling `cmp.getEvent("cmpEvent")`, where `cmpEvent` matches the value of the name attribute in the `<aura:registerEvent>` tag in the component markup. The controller sets the `message` attribute of the event and fires the event.

```
/* ceNotifierController.js */
{
    fireComponentEvent : function(cmp, event) {
        // Get the component event by using the
        // name value from aura:registerEvent
        var cmpEvent = cmp.getEvent("cmpEvent");
        cmpEvent.setParams({
            "message" : "A component event fired me. " +
            "It all happened so fast. Now, I'm here!" });
        cmpEvent.fire();
    }
}
```

Handler Component

The `c:ceHandler` handler component contains the `c:ceNotifier` component. The `<aura:handler>` tag uses the same value of the `name` attribute, `cmpEvent`, from the `<aura:registerEvent>` tag in `c:ceNotifier`. This wires up `c:ceHandler` to handle the event bubbled up from `c:ceNotifier`.

When the event is fired, the `handleComponentEvent` action in the client-side controller of the handler component is invoked.

```
<!--c:ceHandler-->
<aura:component>
    <aura:attribute name="messageFromEvent" type="String"/>
    <aura:attribute name="numEvents" type="Integer" default="0"/>

    <!-- Note that name="cmpEvent" in aura:registerEvent
     in ceNotifier.cmp -->
    <aura:handler name="cmpEvent" event="c:ceEvent" action="{!c.handleComponentEvent}"/>
```

```
    <!-- handler contains the notifier component -->
    <c:ceNotifier />

    <p>{!v.messageFromEvent}</p>
    <p>Number of events: {!v.numEvents}</p>

</aura:component>
```

The controller retrieves the data sent in the event and uses it to update the `messageFromEvent` attribute in the handler component.

```
/* ceHandlerController.js */
{
    handleComponentEvent : function(cmp, event) {
        var message = event.getParam("message");

        // set the handler attributes based on event data
        cmp.set("v.messageFromEvent", message);
        var numEventsHandled = parseInt(cmp.get("v.numEvents")) + 1;
        cmp.set("v.numEvents", numEventsHandled);
    }
}
```

Put It All Together

Navigate to the `c:ceHandler` component and click the button to fire the component event.

`http://localhost:<port>/c/ceHandler.cmp`.

If you want to access data on the server, you could extend this example to call a server-side controller from the handler's client-side controller.

SEE ALSO:

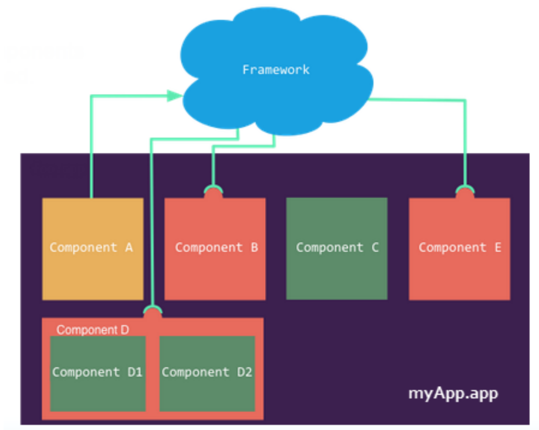
Component Events

Creating Server-Side Logic with Controllers

Application Event Example

Application Events

Application events follow a traditional publish-subscribe model. An application event is fired from an instance of a component. All components that provide a handler for the event are notified.



IN THIS SECTION:

Application Event Propagation

The framework supports *capture*, *bubble*, and *default* phases for the propagation of application events. The capture and bubble phases are similar to DOM handling patterns and provide an opportunity for interested components to interact with an event and potentially control the behavior for subsequent handlers. The default phase preserves the framework's original handling behavior.

Create Custom Application Events

Create a custom application event using the `<aura:event>` tag in a `.evt` resource. Events can contain attributes that can be set before the event is fired and read when the event is handled.

Fire Application Events

Application events follow a traditional publish-subscribe model. An application event is fired from an instance of a component. All components that provide a handler for the event are notified.

Handling Application Events

Use `<aura:handler>` in the markup of the handler component.

SEE ALSO:

Component Events

Handling Events with Client-Side Controllers

Application Event Propagation

Advanced Events Example

Application Event Propagation

The framework supports *capture*, *bubble*, and *default* phases for the propagation of application events. The capture and bubble phases are similar to DOM handling patterns and provide an opportunity for interested components to interact with an event and potentially control the behavior for subsequent handlers. The default phase preserves the framework's original handling behavior.

The component that fires an event is known as the source component. The framework allows you to handle the event in different phases. These phases give you flexibility for how to best process the event for your application.

The phases are:

Capture

The event is captured and trickles down from the application root to the source component. The event can be handled by a component in the containment hierarchy that receives the captured event.

Event handlers are invoked in order from the application root down to the source component that fired the event.

Any registered handler in this phase can stop the event from propagating, at which point no more handlers are called in this phase or the bubble phase. If a component stops the event propagation using `event.stopPropagation()`, the component becomes the root node used in the default phase.

Any registered handler in this phase can cancel the default behavior of the event by calling `event.preventDefault()`. This call prevents execution of any of the handlers in the default phase.

Bubble

The component that fired the event can handle it. The event then bubbles up from the source component to the application root. The event can be handled by a component in the containment hierarchy that receives the bubbled event.

Event handlers are invoked in order from the source component that fired the event up to the application root.

Any registered handler in this phase can stop the event from propagating, at which point no more handlers will be called in this phase. If a component stops the event propagation using `event.stopPropagation()`, the component becomes the root node used in the default phase.

Any registered handler in this phase can cancel the default behavior of the event by calling `event.preventDefault()`. This call prevents execution of any of the handlers in the default phase.

Default

Event handlers are invoked in a non-deterministic order from the root node through its subtree. The default phase doesn't have the same propagation rules related to component hierarchy as the capture and bubble phases. The default phase can be useful for handling application events that affect components in different sub-trees of your app.

If the event's propagation wasn't stopped in a previous phase, the root node defaults to the application root. If the event's propagation was stopped in a previous phase, the root node is set to the component whose handler invoked `event.stopPropagation()`.

Here is the sequence of application event propagation.

1. **Event fired**—An application event is fired. The component that fires the event is known as the source component.
2. **Capture phase**—The framework executes the capture phase from the application root to the source component until all components are traversed. Any handling event can stop propagation by calling `stopPropagation()` on the event.
3. **Bubble phase**—The framework executes the bubble phase from the source component to the application root until all components are traversed or `stopPropagation()` is called.
4. **Default phase**—The framework executes the default phase from the root node unless `preventDefault()` was called in the capture or bubble phases. If the event's propagation wasn't stopped in a previous phase, the root node defaults to the application root. If the event's propagation was stopped in a previous phase, the root node is set to the component whose handler invoked `event.stopPropagation()`.

Create Custom Application Events

Create a custom application event using the `<aura:event>` tag in a `.evt` resource. Events can contain attributes that can be set before the event is fired and read when the event is handled.

Use `type="APPLICATION"` in the `<aura:event>` tag for an application event. For example, this `c:appEvent` application event has one attribute with a name of `message`.

```
<!--c:appEvent-->
<aura:event type="APPLICATION">
```

```
    <!-- Add aura:attribute tags to define event shape.
         One sample attribute here. -->
    <aura:attribute name="message" type="String"/>
</aura:event>
```

The component that fires an event can set the event's data. To set the attribute values, call `event.setParam()` or `event.setParams()`. A parameter name set in the event must match the `name` attribute of an `<aura:attribute>` in the event. For example, if you fire `c:appEvent`, you could use:

```
event.setParam("message", "event message here");
```

The component that handles an event can retrieve the event data. To retrieve the attribute in this event, call `event.getParam("message")` in the handler's client-side controller.

Fire Application Events

Application events follow a traditional publish-subscribe model. An application event is fired from an instance of a component. All components that provide a handler for the event are notified.

Register an Event

A component registers that it may fire an application event by using `<aura:registerEvent>` in its markup. The `name` attribute is required but not used for application events. The `name` attribute is only relevant for component events. This example uses `name="appEvent"` but the value isn't used anywhere.

```
<aura:registerEvent name="appEvent" type="c:appEvent"/>
```

Fire an Event

Use `$A.get("e.myNamespace:myAppEvent")` in JavaScript to get an instance of the `myAppEvent` event in the `myNamespace` namespace.

Note: The syntax to get an instance of an application event is different than the syntax to get a component event, which is `cmp.getEvent("`***`evtName`***`")`.

Use `fire()` to fire the event.

```
var appEvent = $A.get("e.c:appEvent");
// Optional: set some data for the event (also known as event shape)
// A parameter's name must match the name attribute
// of one of the event's <aura:attribute> tags
//appEvent.setParams({ "myParam" : myValue });
appEvent.fire();
```

Events Fired on App Rendering

Some events are automatically fired when an app is rendering. For more information, see Events Fired During the Rendering Lifecycle on page 139.

SEE ALSO:

Fire Component Events

Handling Application Events

Use `<aura:handler>` in the markup of the handler component.

For example:

```
<aura:handler event="c:appEvent" action="{!c.handleApplicationEvent}"/>
```

The `event` attribute specifies the event being handled. The format is ***`namespace:eventName`***.

The `action` attribute of `<aura:handler>` sets the client-side controller action to handle the event.

Note: The handler for an application event won't work if you set the `name` attribute in `<aura:handler>`. Use the `name` attribute only when you're handling component events.

In this example, when the event is fired, the `handleApplicationEvent` client-side controller action is called.

Event Handling Phases

The framework allows you to handle the event in different phases. These phases give you flexibility for how to best process the event for your application.

Application event handlers are associated with the default phase. To add a handler for the capture or bubble phases instead, use the `phase` attribute.

Get the Source of an Event

In the client-side controller action for an `<aura:handler>` tag, use `evt.getSource()` to find out which component fired the event, where `evt` is a reference to the event. To retrieve the source element, use `evt.getSource().getElement()`.

IN THIS SECTION:

SEE ALSO:

Handling Component Events

Handling Bubbled or Captured Application Events

Event propagation rules determine which components in the containment hierarchy can handle events by default in the bubble or capture phases. Learn about the rules and how to handle events in the bubble or capture phases.

The framework supports *capture*, *bubble*, and *default* phases for the propagation of application events. The capture and bubble phases are similar to DOM handling patterns and provide an opportunity for interested components to interact with an event and potentially control the behavior for subsequent handlers. The default phase preserves the framework's original handling behavior.

Default Event Propagation Rules

By default, every parent in the containment hierarchy can't handle an event during the capture and bubble phases. Instead, the event propagates to every owner in the containment hierarchy.

A component's owner is the component that is responsible for its creation. For declaratively created components, the owner is the outermost component containing the markup that references the component firing the event. For programmatically created components, the owner component is the component that invoked `$A.createComponent` to create it.

The same rules apply for the capture phase, although the direction of event propagation (down) is the opposite of the bubble phase (up).

Confused? It makes more sense when you look at an example in the bubbling phase.

`c:owner` contains `c:container`, which in turn contains `c:eventSource`.

```
<!--c:owner-->
<aura:component>
    <c:container>
        <c:eventSource />
    </c:container>
</aura:component>
```

If `c:eventSource` fires an event, it can handle the event itself. The event then bubbles up the containment hierarchy.

`c:container` contains `c:eventSource` but it's not the owner because it's not the outermost component in the markup, so it can't handle the bubbled event.

`c:owner` is the owner because `c:container` is in its markup. `c:owner` can handle the event.

Propagation to All Container Components

The default behavior doesn't allow an event to be handled by every parent in the containment hierarchy. Some components contain other components but aren't the owner of those components. These components are known as container components. In the example, `c:container` is a container component because it's not the owner for `c:eventSource`. By default, `c:container` can't handle events fired by `c:eventSource`.

A container component has a facet attribute whose type is `Aura.Component[]`, such as the default `body` attribute. The container component includes those components in its definition using an expression, such as `{!v.body}`. The container component isn't the owner of the components rendered with that expression.

To allow a container component to handle the event, add `includeFacets="true"` to the `<aura:handler>` tag of the container component. For example, adding `includeFacets="true"` to the handler in the container component, `c:container`, enables it to handle the component event bubbled from `c:eventSource`.

```
<aura:handler name="bubblingEvent" event="c:compEvent" action="{!c.handleBubbling}"
    includeFacets="true" />
```

Handle Bubbled Event

To add a handler for the bubble phase, set `phase="bubble"`.

```
<aura:handler event="c:appEvent" action="{!c.handleBubbledEvent}"
    phase="bubble" />
```

The `event` attribute specifies the event being handled. The format is ***`namespace:eventName`***.

The `action` attribute of `<aura:handler>` sets the client-side controller action to handle the event.

Handle Captured Event

To add a handler for the capture phase, set `phase="capture"`.

```
<aura:handler event="c:appEvent" action="{!c.handleCapturedEvent}"
    phase="capture" />
```

Stop Event Propagation

Use the `stopPropagation()` method in the `Event` object to stop the event propagating to other components.

Pausing Event Propagation for Asynchronous Code Execution

Use `event.pause()` to pause event handling and propagation until `event.resume()` is called. This flow-control mechanism is useful for any decision that depends on the response from the execution of asynchronous code. For example, you might make a decision about event propagation based on the response from an asynchronous call to native mobile code.

You can call `pause()` or `resume()` in the capture or bubble phases.

Application Event Example

Here's a simple use case of using an application event to update an attribute in another component.

1. A user clicks a button in the notifier component, `aeNotifier.cmp`.
2. The client-side controller for `aeNotifier.cmp` sets a message in a component event and fires the event.
3. The handler component, `aeHandler.cmp`, handles the fired event.
4. The client-side controller for `aeHandler.cmp` sets an attribute in `aeHandler.cmp` based on the data sent in the event.

Application Event

The `aeEvent.evt` application event has one attribute. We'll use this attribute to pass some data in the event when it's fired.

```
<!--c:aeEvent-->
<aura:event type="APPLICATION">
    <aura:attribute name="message" type="String"/>
</aura:event>
```

Notifier Component

The `aeNotifier.cmp` notifier component uses `aura:registerEvent` to declare that it may fire the application event. The `name` attribute is required but not used for application events. The `name` attribute is only relevant for component events.

The button in the component contains a `onclick` browser event that is wired to the `fireApplicationEvent` action in the client-side controller. Clicking this button invokes the action.

```
<!--c:aeNotifier-->
<aura:component>
    <aura:registerEvent name="appEvent" type="c:aeEvent"/>

    <h1>Simple Application Event Sample</h1>
    <p><lightning:button
        label="Click here to fire an application event"
```

```
        onclick="{!c.fireApplicationEvent}" />
    </p>
</aura:component>
```

The client-side controller gets an instance of the event by calling `$A.get("e.c:aeEvent")`. The controller sets the `message` attribute of the event and fires the event.

```
/* aeNotifierController.js */
{
    fireApplicationEvent : function(cmp, event) {
        // Get the application event by using the
        // e.<namespace>.<event> syntax
        var appEvent = $A.get("e.c:aeEvent");
        appEvent.setParams({
            "message" : "An application event fired me. " +
            "It all happened so fast. Now, I'm everywhere!" });
        appEvent.fire();
    }
}
```

Handler Component

The `aeHandler.cmp` handler component uses the `<aura:handler>` tag to register that it handles the application event.

Note: The handler for an application event won't work if you set the `name` attribute in `<aura:handler>`. Use the `name` attribute only when you're handling component events.

When the event is fired, the `handleApplicationEvent` action in the client-side controller of the handler component is invoked.

```
<!--c:aeHandler-->
<aura:component>
    <aura:attribute name="messageFromEvent" type="String"/>
    <aura:attribute name="numEvents" type="Integer" default="0"/>

    <aura:handler event="c:aeEvent" action="{!c.handleApplicationEvent}"/>

    <p>{!v.messageFromEvent}</p>
    <p>Number of events: {!v.numEvents}</p>
</aura:component>
```

The controller retrieves the data sent in the event and uses it to update the `messageFromEvent` attribute in the handler component.

```
/* aeHandlerController.js */
{
    handleApplicationEvent : function(cmp, event) {
        var message = event.getParam("message");

        // set the handler attributes based on event data
        cmp.set("v.messageFromEvent", message);
        var numEventsHandled = parseInt(cmp.get("v.numEvents")) + 1;
        cmp.set("v.numEvents", numEventsHandled);
    }
}
```

Container Component

The `aeContainer.cmp` container component contains the notifier and handler components. This is different from the component event example where the handler contains the notifier component.

```
<!--c:aeContainer-->
<aura:component>
    <c:aeNotifier/>
    <c:aeHandler/>
</aura:component>
```

Put It All Together

You can test this code by navigating to:

`http://localhost:<port>/c/aeContainer.cmp`.

If you want to access data on the server, you could extend this example to call a server-side controller from the handler's client-side controller.

SEE ALSO:

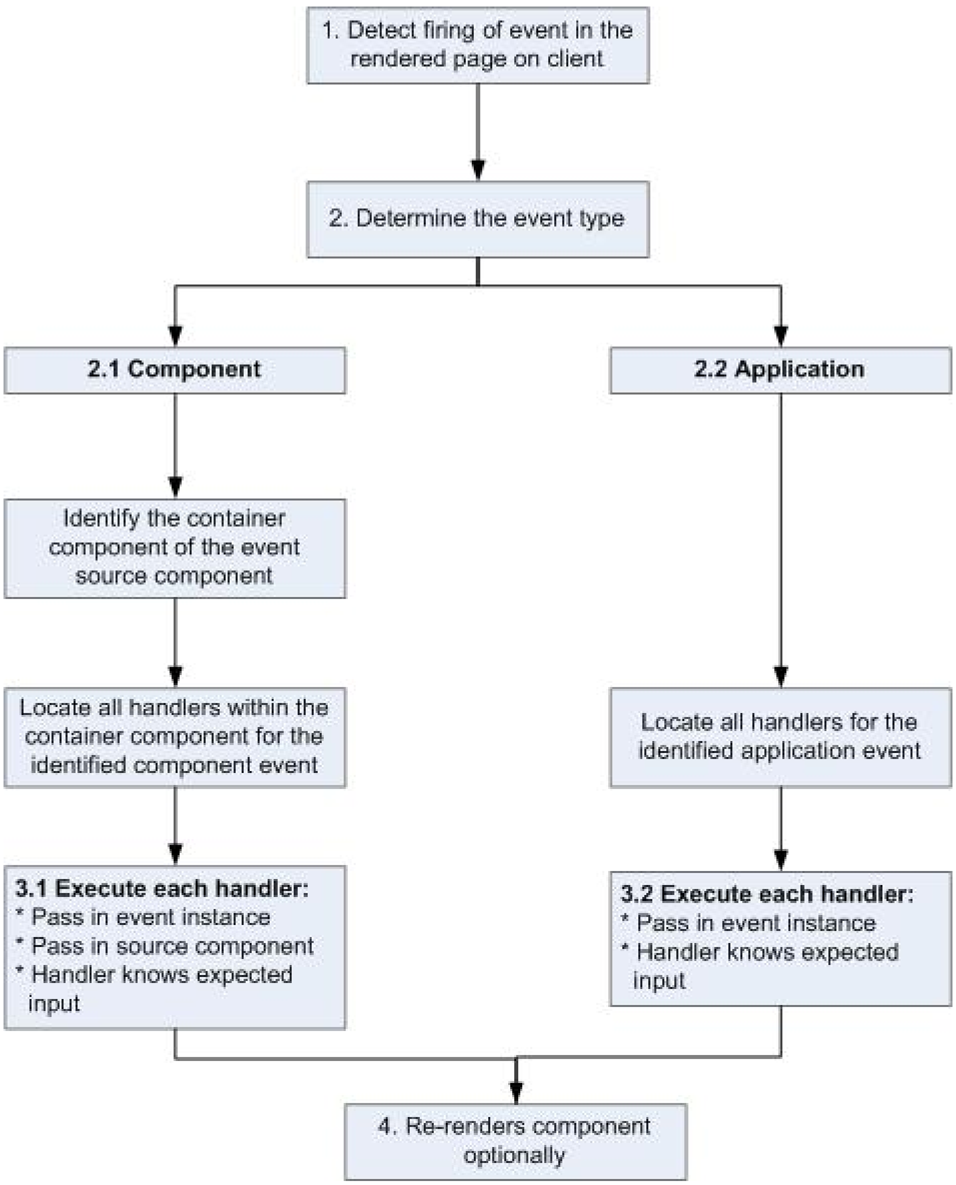
Application Events

Creating Server-Side Logic with Controllers

Component Event Example

Event Handling Lifecycle

The following chart summarizes how the framework handles events.



1 Detect Firing of Event

The framework detects the firing of an event. For example, the event could be triggered by a button click in a notifier component.

2 Determine the Event Type

2.1 Component Event

The parent or container component instance that fired the event is identified. This container component locates all relevant event handlers for further processing.

2.2 Application Event

Any component can have an event handler for this event. All relevant event handlers are located.

3 Execute each Handler

3.1 Executing a Component Event Handler

Each of the event handlers defined in the container component for the event are executed by the handler controller, which can also:

- Set attributes or modify data on the component (causing a re-rendering of the component).
- Fire another event or invoke a client-side or server-side action.

3.2 Executing an Application Event Handler

All event handlers are executed. When the event handler is executed, the event instance is passed into the event handler.

4 Re-render Component (optional)

After the event handlers and any callback actions are executed, a component might be automatically re-rendered if it was modified during the event handling process.

SEE ALSO:

Create a Custom Renderer

Advanced Events Example

This example builds on the simpler component and application event examples. It uses one notifier component and one handler component that work with both component and application events. Before we see a component wired up to events, let's look at the individual resources involved.

This table summarizes the roles of the various resources used in the example. The source code for these resources is included after the table.

Resource	Resource Name	Usage
Event files	Component event (`compEvent.evt`) and application event (`appEvent.evt`)	Defines the component and application events in separate resources. `eventsContainer.cmp` shows how to use both component and application events.
Notifier	Component (`eventsNotifier.cmp`) and its controller (`eventsNotifierController.js`)	The notifier contains an `onclick` browser event to initiate the event. The controller fires the event.
Handler	Component (`eventsHandler.cmp`) and its controller (`eventsHandlerController.js`)	The handler component contains the notifier component (or a `<aura:handler>` tag for application events), and calls the controller action that is executed after the event is fired.
Container Component	`eventsContainer.cmp`	Displays the event handlers on the UI for the complete demo.

The definitions of component and application events are stored in separate `.evt` resources, but individual notifier and handler component bundles can contain code to work with both types of events.

The component and application events both contain a `context` attribute that defines the shape of the event. This is the data that is passed to handlers of the event.

Component Event

Here is the markup for `compEvent.evt`.

```
<!--c:compEvent-->
<aura:event type="COMPONENT">
    <!-- pass context of where the event was fired to the handler. -->
    <aura:attribute name="context" type="String"/>
</aura:event>
```

Application Event

Here is the markup for `appEvent.evt`.

```
<!--c:appEvent-->
<aura:event type="APPLICATION">
    <!-- pass context of where the event was fired to the handler. -->
    <aura:attribute name="context" type="String"/>
</aura:event>
```

Notifier Component

The `eventsNotifier.cmp` notifier component contains buttons to initiate a component or application event.

The notifier uses `aura:registerEvent` tags to declare that it may fire the component and application events. Note that the `name` attribute is required but the value is only relevant for the component event; the value is not used anywhere else for the application event.

The `parentName` attribute is not set yet. We will see how this attribute is set and surfaced in `eventsContainer.cmp`.

```
<!--c:eventsNotifier-->
<aura:component>
  <aura:attribute name="parentName" type="String"/>
  <aura:registerEvent name="componentEventFired" type="c:compEvent"/>
  <aura:registerEvent name="appEvent" type="c:appEvent"/>

  <div>
    <h3>This is {!v.parentName}'s eventsNotifier.cmp instance</h3>
    <p><ui:button
        label="Click here to fire a component event"
        press="{!c.fireComponentEvent}" />
    </p>
    <p><ui:button
        label="Click here to fire an application event"
        press="{!c.fireApplicationEvent}" />
    </p>
  </div>
</aura:component>
```

CSS source

The CSS is in `eventsNotifier.css`.

```
/* eventsNotifier.css */
.cEventsNotifier {
```

```
    display: block;
    margin: 10px;
    padding: 10px;
    border: 1px solid black;
}
```

Client-side controller source

The `eventsNotifierController.js` controller fires the event.

```
/* eventsNotifierController.js */
{
    fireComponentEvent : function(cmp, event) {
        var parentName = cmp.get("v.parentName");

        // Look up event by name, not by type
        var compEvents = cmp.getEvent("componentEventFired");

        compEvents.setParams({ "context" : parentName });
        compEvents.fire();
    },

    fireApplicationEvent : function(cmp, event) {
        var parentName = cmp.get("v.parentName");

        // note different syntax for getting application event
        var appEvent = $A.get("e.c:appEvent");

        appEvent.setParams({ "context" : parentName });
        appEvent.fire();
    }
}
```

You can click the buttons to fire component and application events but there is no change to the output because we haven't wired up the handler component to react to the events yet.

The controller sets the `context` attribute of the component or application event to the `parentName` of the notifier component before firing the event. We will see how this affects the output when we look at the handler component.

Handler Component

The `eventsHandler.cmp` handler component contains the `c:eventsNotifier` notifier component and `<aura:handler>` tags for the application and component events.

```
<!--c:eventsHandler-->
<aura:component>
  <aura:attribute name="name" type="String"/>
  <aura:attribute name="mostRecentEvent" type="String" default="Most recent event handled:"/>

  <aura:attribute name="numComponentEventsHandled" type="Integer" default="0"/>
  <aura:attribute name="numApplicationEventsHandled" type="Integer" default="0"/>

  <aura:handler event="c:appEvent" action="{!c.handleApplicationEventFired}"/>
  <aura:handler name="componentEventFired" event="c:compEvent"
action="{!c.handleComponentEventFired}"/>
```

```
  <div>
    <h3>This is {!v.name}</h3>
    <p>{!v.mostRecentEvent}</p>
    <p># component events handled: {!v.numComponentEventsHandled}</p>
    <p># application events handled: {!v.numApplicationEventsHandled}</p>
    <c:eventsNotifier parentName="{#v.name}" />
  </div>
</aura:component>
```

Note: `{#v.name}` is an unbound expression. This means that any change to the value of the `parentName` attribute in `c:eventsNotifier` doesn't propagate back to affect the value of the `name` attribute in `c:eventsHandler`. For more information, see Data Binding Between Components on page 46.

CSS source

The CSS is in `eventsHandler.css`.

```
/* eventsHandler.css */
.cEventsHandler {
  display: block;
  margin: 10px;
  padding: 10px;
  border: 1px solid black;
}
```

Client-side controller source

The client-side controller is in `eventsHandlerController.js`.

```
/* eventsHandlerController.js */
{
    handleComponentEventFired : function(cmp, event) {
        var context = event.getParam("context");
        cmp.set("v.mostRecentEvent",
            "Most recent event handled: COMPONENT event, from " + context);

        var numComponentEventsHandled =
            parseInt(cmp.get("v.numComponentEventsHandled")) + 1;
        cmp.set("v.numComponentEventsHandled", numComponentEventsHandled);
    },

    handleApplicationEventFired : function(cmp, event) {
        var context = event.getParam("context");
        cmp.set("v.mostRecentEvent",
            "Most recent event handled: APPLICATION event, from " + context);

        var numApplicationEventsHandled =
            parseInt(cmp.get("v.numApplicationEventsHandled")) + 1;
        cmp.set("v.numApplicationEventsHandled", numApplicationEventsHandled);
    }
}
```

The `name` attribute is not set yet. We will see how this attribute is set and surfaced in `eventsContainer.cmp`.

You can click buttons and the UI now changes to indicate the type of event. The click count increments to indicate whether it's a component or application event. We aren't finished yet though. Notice that the source of the event is undefined as the event `context` attribute hasn't been set .

Container Component

Here is the markup for `eventsContainer.cmp`.

```
<!--c:eventsContainer-->
<aura:component>
    <c:eventsHandler name="eventsHandler1"/>
    <c:eventsHandler name="eventsHandler2"/>
</aura:component>
```

The container component contains two handler components. It sets the `name` attribute of both handler components, which is passed through to set the `parentName` attribute of the notifier components. This fills in the gaps in the UI text that we saw when we looked at the notifier or handler components directly.

Navigate to the `c:eventsContainer` component.

`http://localhost:<port>/c/eventsContainer.cmp`.

Click the **Click here to fire a component event** button for either of the event handlers. Notice that the **# component events handled** counter only increments for that component because only the firing component's handler is notified.

Click the **Click here to fire an application event** button for either of the event handlers. Notice that the **# application events handled** counter increments for both the components this time because all the handling components are notified.

SEE ALSO:

Component Event Example
Application Event Example
Event Handling Lifecycle

Firing Aura Events from Non-Aura Code

You can fire Aura events from JavaScript code outside an Aura app. For example, your Aura app might need to call out to some non-Aura code, and then have that code communicate back to your Aura app once it's done.

For example, you could call external code that needs to log into another system and return some data to your Aura app. Let's call this event `mynamespace:externalEvent`. You'll fire this event when your non-Aura code is done by including this JavaScript in your non-Aura code.

```
var myExternalEvent;
    if(window.opener.$A &&
      (myExternalEvent = window.opener.$A.get("e.mynamespace:externalEvent"))) {
         myExternalEvent.setParams({isOauthed:true});
         myExternalEvent.fire();
       }
```

`window.opener.$A.get()` references the master window where your Aura app is loaded.

SEE ALSO:

Application Events

Modifying Components Outside the Framework Lifecycle

Events Best Practices

Here are some best practices for working with events.

Use Component Events Whenever Possible

Always try to use a component event instead of an application event, if possible. Component events can only be handled by components above them in the containment hierarchy so their usage is more localized to the components that need to know about them. Application events are best used for something that should be handled at the application level, such as navigating to a specific record. Application events allow communication between components that are in separate parts of the application and have no direct containment relationship.

Separate Low-Level Events from Business Logic Events

It's a good practice to handle low-level events, such as a click, in your event handler and refire them as higher-level events, such as an `approvalChange` event or whatever is appropriate for your business logic.

Dynamic Actions based on Component State

If you need to invoke a different action on a click event depending on the state of the component, try this approach:

1. Store the component state as a discrete value, such as New or Pending, in a component attribute.
2. Put logic in your client-side controller to determine the next action to take.
3. If you need to reuse the logic in your component bundle, put the logic in the helper.

For example:

1. Your component markup contains `<ui:button label="do something" press="{!c.click}" />`.
2. In your controller, define the `click` function, which delegates to the appropriate helper function or potentially fires the correct event.

Using a Dispatcher Component to Listen and Relay Events

If you have a large number of handler component instances listening for an event, it may be better to identify a dispatcher component to listen for the event. The dispatcher component can perform some logic to decide which component instances should receive further information and fire another component or application event targeted at those component instances.

SEE ALSO:

Handling Events with Client-Side Controllers

Events Anti-Patterns

Events Anti-Patterns

These are some anti-patterns that you should avoid when using events.

Don't Fire an Event in a Renderer

Firing an event in a renderer can cause an infinite rendering loop.

Don't do this!

```
afterRender: function(cmp, helper) {
    this.superAfterRender();
    $A.get("e.myns:mycmp").fire();
}
```

Instead, use the `init` hook to run a controller action after component construction but before rendering. Add this code to your component:

```
<aura:handler name="init" value="{!this}" action="{!c.doInit}"/>
```

For more details, see .Invoking Actions on Component Initialization on page 167.

Don't Use `onclick` and `ontouchend` Events

You can't use different actions for `onclick` and `ontouchend` events in a component. The framework translates touch-tap events into clicks and activates any `onclick` handlers that are present.

SEE ALSO:

- Create a Custom Renderer
- Events Best Practices

Events Fired During the Rendering Lifecycle

A component is instantiated, rendered, and rerendered during its lifecycle. A component is rerendered only when there's a programmatic or value change that would require a rerender, such as when a browser event triggers an action that updates its data.

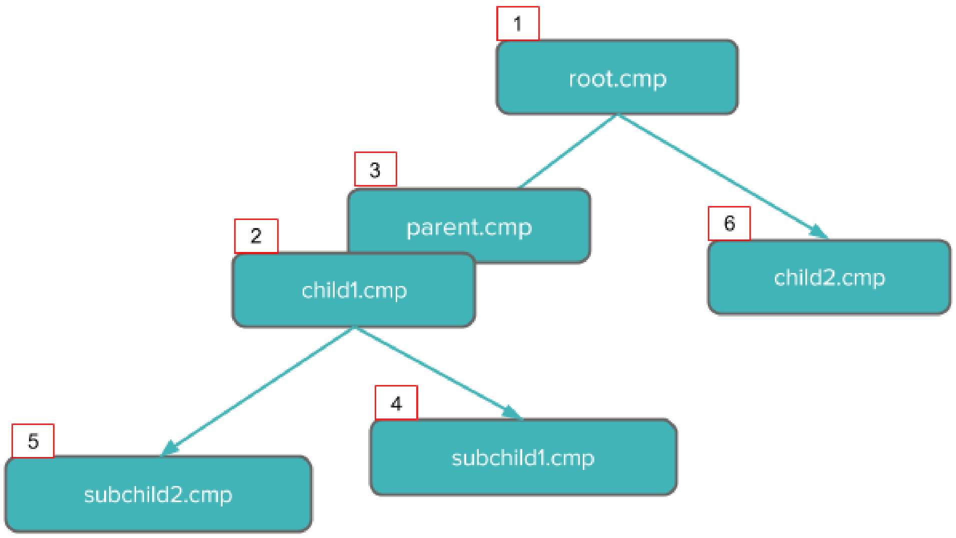
Component Creation

The component lifecycle starts when the client sends an HTTP request to the server and the component configuration data is returned to the client. No server trip is made if the component definition is already on the client from a previous request and the component has no server dependencies.

Let's look at an app with several nested components. The framework instantiates the app and goes through the children of the `v.body` facet to create each component, First, it creates the component definition, its entire parent hierarchy, and then creates the facets within those components. The framework also creates any component dependencies on the server, including definitions for attributes, interfaces, controllers, actions, and models.

For an abstract component, your JavaScript or Java provider determines which concrete implementation of the component to create.

The following image lists the order of component creation.



After creating a component instance, the serialized component definitions and instances are sent down to the client. Definitions are cached but not the instance data. The client deserializes the response to create the JavaScript objects or maps, resulting in an instance tree that's used to render the component instance. When the component tree is ready, the `init` event is fired for all the components, starting from the children component and finishing in the parent component.

Component Rendering

The rendering lifecycle happens once in the lifetime of a component unless the component gets explicitly unrendered. When you create a component:

1. The component service that constructs the components fires the `init` event to signal that initialization has completed.

   ```
   <aura:handler name="init" value="{!this}" action="{!c.doInit}"/>
   ```

   You can customize the `init` handler and add your own controller logic before the component starts rendering. For more information, see Invoking Actions on Component Initialization on page 167.

2. For each component in the tree, the base implementation of `render()` or your custom renderer is called to start component rendering. For more information, see Create a Custom Renderer on page 182. Similar to the component creation process, rendering starts at the root component, its children components and their super components, if any, and finally the subchildren components.

3. Once your components are rendered to the DOM, `afterRender()` is called to signal that rendering is completed for each of these component definitions. It enables you to interact with the DOM tree after the framework rendering service has created the DOM elements.

4. To indicate that the client is done waiting for a response to the server request XHR, the `aura:doneWaiting` event is fired. You can handle this event by adding a handler wired to a client-side controller action.

   Note: The `aura:doneWaiting` event is deprecated. The `aura:doneWaiting` application event is fired for every server response, even for responses from other components in your app. Unless your component is running in complete isolation in a standalone app and not included in Lightning Experience or the Salesforce app, the container app may trigger your event handler multiple times. This behavior makes it difficult to handle each event appropriately.

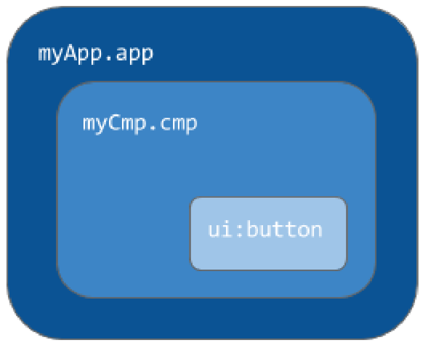
5. The framework fires a `render` event, enabling you to interact with the DOM tree after the framework's rendering service has inserted DOM elements. Handling the `render` event is preferred to creating a custom renderer and overriding `afterRender()`. For more information, see Handle the render Event.

6. Finally, the `aura:doneRendering` event is fired at the end of the rendering lifecycle.

   Note: The `aura:doneRendering` event is deprecated. Unless your component is running in complete isolation in a standalone app and not included in complex apps, such as Lightning Experience or the Salesforce app, the container app may trigger your event handler multiple times. This behavior makes it difficult to handle each event appropriately.

Rendering Nested Components

Let's say that you have an app `myApp.app` that contains a component `myCmp.cmp` with a `ui:button` component.



During initialization, the `init()` event is fired in this order: `ui:button`, `ui:myCmp`, and `myApp.app`.

SEE ALSO:

Create a Custom Renderer
Server-Side Processing for Component Requests
Client-Side Processing for Component Requests

System Events

The framework fires several system events during its lifecycle.

You can handle these events in your Lightning apps or components, and within the Salesforce mobile app.

Event Name	Description
`aura:doneRendering` (deprecated)	Indicates that the initial rendering of the root application has completed. Note: The `aura:doneRendering` event is deprecated. Unless your component is running in complete isolation in a standalone app and not included in complex apps, such as Lightning Experience or the Salesforce app, the container app may trigger your event handler multiple times. This behavior makes it difficult to handle each event appropriately.

Event Name	Description
`aura:doneWaiting` (deprecated)	Indicates that the app is done waiting for a response to a server request. This event is preceded by an `aura:waiting` event. Note: The `aura:doneWaiting` event is deprecated. The `aura:doneWaiting` application event is fired for every server response, even for responses from other components in your app. Unless your component is running in complete isolation in a standalone app and not included in Lightning Experience or the Salesforce app, the container app may trigger your event handler multiple times. This behavior makes it difficult to handle each event appropriately.
`aura:locationChange`	Indicates that the hash part of the URL has changed.
`aura:noAccess`	Indicates that a requested resource is not accessible due to security constraints on that resource.
`aura:systemError`	Indicates that an error has occurred.
`aura:valueChange`	Indicates that an attribute value has changed.
`aura:valueDestroy`	Indicates that a component has been destroyed.
`aura:valueInit`	Indicates that an app or component has been initialized.
`aura:valueRender`	Indicates that an app or component has been rendered or rerendered.
`aura:waiting` (deprecated)	Indicates that the app is waiting for a response to a server request. Note: The `aura:waiting` event is deprecated. The `aura:waiting` application event is fired for every server request, even for requests from other components in your app. Unless your component is running in complete isolation in a standalone app and not included in Lightning Experience or the Salesforce app, the container app may trigger your event handler multiple times. This behavior makes it difficult to handle each event appropriately.

CHAPTER 5 Creating Apps

In this chapter ...

Components are the building blocks of an app. This section shows you a typical workflow to put the pieces together to create a new app.

App Overview

An app is a special top-level component whose markup is in a `.app` file.

On a production server, the `.app` file is the only addressable unit in a browser URL. Access an app using the URL:

`http://<myServer>/<namespace>/<appName>.app`

Note: You can access components directly in a browser URL in `DEV` mode by using the component's `.cmp` extension.

SEE ALSO:

aura:application

Supported HTML Tags

Designing App UI

Design your app's UI by including markup in the `.app` resource. Each part of your UI corresponds to a component, which can in turn contain nested components. Compose components to create a sophisticated app.

An app's markup starts with the `<aura:application>` tag.

Note: To learn more about the `<aura:application>` tag, see aura:application.

Let's look at a `sample.app` file, which starts with the `<aura:application>` tag.

```
<aura:application extends="force:slds">
    <lightning:layout>
        <lightning:layoutItem padding="around-large">
            <h1 class="slds-text-heading_large">Sample App</h1>
        </lightning:layoutItem>
    </lightning:layout>
    <lightning:layout>
        <lightning:layoutItem padding="around-small">
            Sidebar
            <!-- Other component markup here -->
        </lightning:layoutItem>
        <lightning:layoutItem padding="around-small">
            Content
            <!-- Other component markup here -->
        </lightning:layoutItem>
    </lightning:layout>

</aura:application>
```

The `sample.app` file contains HTML tags, such as `<h1>`, as well as components, such as `<lightning:layout>`. We won't go into the details for all the components here but note how simple the markup is. The `<lightning:layoutItem>` component can contain other components or HTML markup.

SEE ALSO:

aura:application

Creating App Templates

An app template bootstraps the loading of the framework and the app. Customize an app's template by creating a component that extends the default `aura:template` template.

A template must have the `isTemplate` system attribute in the `<aura:component>` tag set to `true`. This informs the framework to allow restricted items, such as `<script>` tags, which aren't allowed in regular components.

For example, a sample app has a `np:template` template that extends `aura:template`. `np:template` looks like:

```
<aura:component isTemplate="true" extends="aura:template">
    <aura:set attribute="title" value="My App"/>
    ...
</aura:component>
```

Note how the component extends `aura:template` and sets the `title` attribute using `aura:set`.

The app points at the custom template by setting the `template` system attribute in `<aura:application>`.

```
<aura:application template="np:template">
    ...
</aura:application>
```

A template can only extend a component or another template. A component or an application can't extend a template.

JavaScript Libraries

You can reference a JavaScript library in your app's template. For other options, see Using External JavaScript Libraries on page 169.

To add a JavaScript library to your app's template, use `aura:set` to set the `extraScriptTags` attribute in the template component. This sets the `extraScriptTags` attribute in `aura:template`, which your app's template extends.

This sample template markup references a third-party JavaScript library.

```
<aura:set attribute="extraScriptTags">
    <script type="text/javascript" src="/aura/codemirror/codemirror.js"></script>
</aura:set>
```

You can use multiple `<script>` tags to include more than one library. For example:

```
<aura:set attribute="extraScriptTags">
    <script type="text/javascript" src="/aura/codemirror/codemirror.js"></script>
    <script type="text/javascript" src="/aura/otherLib/otherLib.js"></script>
</aura:set>
```

External CSS

To use an external style sheet, you must link to it in your app's template. Use `aura:set` to set the `extraStyleTags` attribute in the template component. This sets the `extraStyleTags` attribute in `aura:template`, which your app's template extends.

For example:

```
<aura:set attribute="extraStyleTags">
        <link href="/aura/external/google-code-prettify/prettify.css" rel="stylesheet"
type="text/css" />
    </aura:set>
```

You can link to multiple external style sheets. For example:

```
<aura:set attribute="extraStyleTags">
        <link href="/aura/external/google-code-prettify/prettify.css" rel="stylesheet"
type="text/css" />
        <link href="/aura/external/morecss/morecss.css" rel="stylesheet" type="text/css"
/>
    </aura:set>
```

You can also use inline style in your template, but we recommend using an external style sheet instead. To use inline style, use `aura:set` to set the `inlineStyle` attribute in the template component. For example:

```
<aura:set attribute="inlineStyle">
        <style>
            body {
             background-color: #6cc4e3;
            }
        </style>
    </aura:set>
```

SEE ALSO:

aura:application

CSS in Components

Using External JavaScript Libraries

Using the AppCache

AppCache support is deprecated. Browser vendors have deprecated AppCache, so we followed their lead. Remove the `useAppcache` attribute in the `<aura:application>` tag of your standalone apps (`.app` files) to avoid cross-browser support issues due to deprecation by browser vendors.

If you don't currently set `useAppcache` in an `<aura:application>` tag, you don't have to do anything because the default value of `useAppcache` is `false`.

Note: See an introduction to AppCache for more information.

SEE ALSO:

Component Request Overview

aura:application

CHAPTER 6 Styling Apps

In this chapter ...

An app is a special top-level component whose markup is in a `.app` resource. Just like any other component, you can put CSS in its bundle in a resource called `<appName>.css`.

For example, if the app markup is in `notes.app`, its CSS is in `notes.css`.

Besides CSS that styles the component in the bundle, you can add a flavor CSS file using the file name `<componentName>Flavors.css`. Flavors enable you to style different component instances easily and apply various styles to components within a namespace.

SEE ALSO:

CSS in Components

Creating App Templates

Add Lightning Components as Custom Tabs in the Salesforce App

Using External CSS

To use external CSS in your app, add it to your app's template.

SEE ALSO:

Using External JavaScript Libraries

More Readable Styling Markup with the `join` Expression

Markup can get messy when you specify the class names to apply based on the component attribute values. Try using a `join` expression for easier-to-read markup.

This example sets the class names based on the component attribute values. It's readable, but the spaces between class names are easy to forget.

```
<li class="{! 'calendarEvent ' +
    v.zoomDirection + ' ' +
    (v.past ? 'pastEvent ' : '') +
    (v.zoomed ? 'zoom ' : '') +
    (v.multiDayFragment ? 'multiDayFragment ' : '')}">
    <!-- content here -->
</li>
```

Sometimes, if the markup is not broken into multiple lines, it can hurt your eyes or make you mutter profanities under your breath.

```
<li class="{! 'calendarEvent ' + v.zoomDirection + ' ' + (v.past ? 'pastEvent ' : '') +
(v.zoomed ? 'zoom ' : '') + (v.multiDayFragment ? 'multiDayFragment ' : '')}">
    <!-- content here -->
</li>
```

Try using a `join` expression instead for easier-to-read markup. This example `join` expression sets `' '` as the first argument so that you don't have to specify it for each subsequent argument in the expression.

```
<li
    class="{! join(' ',
        'calendarEvent',
        v.zoomDirection,
        v.past ? 'pastEvent' : '',
        v.zoomed ? 'zoom' : '',
        v.multiDayFragment ? 'multiDayFragment' : ''
    )}">
    <!-- content here -->
</li>
```

You can also use a `join` expression for dynamic styling.

```
<div style="{! join(';',
    'top:' + v.timeOffsetTop + '%',
    'left:' + v.timeOffsetLeft + '%',
    'width:' + v.timeOffsetWidth + '%'
)}">
```

```
    <!-- content here -->
</div>
```

SEE ALSO:

Expression Functions Reference

Vendor Prefixes

Vendor prefixes, such as `—moz-` and `—webkit-` among many others, are automatically added in Aura.

You only need to write the unprefixed version, and the framework automatically adds any prefixes that are necessary when generating the CSS output. If you choose to add them, they are used as-is. This enables you to specify alternative values for certain prefixes.

Example: For example, this is an unprefixed version of `border-radius`.

```
.class {
  border-radius: 2px;
}
```

The previous declaration results in the following declarations.

```
.class {
  -webkit-border-radius: 2px;
  -moz-border-radius: 2px;
  border-radius: 2px;
}
```

Styling with Flavors

A flavor provides stylistic variations of a component. Each flavor is essentially a CSS class that can apply varying styles to different instances of a components.

Styling with flavors enables you to restyle the original components easily, but also avoid overriding any previous styling. When creating flavors, create them at the component level in component bundles.

To use flavors, you must make a component flavorable. Specify `aura:flavorable="true"` on the HTML element that should receive the flavor class name:

```
<aura:component>
  <div aura:flavorable="true">
     //other markup here
  </div>
</aura:component>
```

Only one element is marked flavorable, and it doesn't have to be a top-level element. For an example, see the `ui:button` component.

Creating and Setting a Flavor

You can create one or more flavors in a component bundle. Use the file name `<componentName>Flavors.css` to wire up the flavors to your component. Note that this CSS file for flavors is different than your regular `<componentName>.css` file. In the flavor CSS file, create your flavor in the format `.THIS--flavorName`. Each selector must be scoped by the flavor name class selector.

```
.THIS--info, .THIS--warning {
  border: 1px solid #eee;
  margin: t(margin);
}

.THIS--info { background-color: blue }
.THIS--warning { background-color: yellow }
```

When creating flavors for a component, move the existing CSS into the default flavor, if possible. The default flavor should be referenced using `.THIS`, which automatically converts to `.THIS--default`. For an example, see the `ui:button` component.

Note: Flavors are applied to an element if it matches the designated or default flavor of the component. When using flavors, we recommend applying little or no CSS in the regular CSS file, and using at least a default flavor in the flavor CSS file.

You can specify different flavor names. For example:

```
<!-- myComponent.cmp -->
<aura:component defaultFlavor="alternative">
  <div aura:flavorable="true">
    //other markup here
  </div>
</aura:component>

/* myComponentFlavors.css */
.THIS { color: red }
.THIS--alternative { color: green }
```

Setting a Flavor on Component Instances

When multiple flavors are available for a component, you can specify which one to use. For example:

```
<ui:button label="Search"/>
<ui:button aura:flavor="primary" label="Submit"/>
```

Specified flavors are not inherited or passed down to children.

You can specify multiple flavors on the same component instance by providing a comma-separated list of flavors in the `aura:flavor` attribute.

```
<ui:button aura:flavor="default, brand" label="Submit"/>
```

Make sure the flavors you specify work together for the component.

IN THIS SECTION:

SEE ALSO:

Dynamically Creating Components

Applying Flavors to a Namespace

You can add flavors for other components within your namespace.

Add flavors for components in another namespace in the flavors bundle (i.e., folder) within your own namespace. Create one flavored CSS file per component you want to flavor, in the format of `namespace-componentNameFlavors.css`, where namespace is the namespace of the component being flavored. For example, to create flavors for the `ui:button` component, create the CSS file `components/myNamespace/flavors/ui-buttonFlavors.css`.

```
<!-- ui/button/button.cmp -->
<aura:component>
  <button aura:flavorable="true">{!v.body}</button>
</aura:component>

/* ui/button/buttonFlavors.css */
.THIS {
  color: red;
  text-shadow: red 0 -2px;
}

/* sample/flavors/ui-buttonFlavors.css */
.THIS { color: green }
.THIS--special { font-weight: bold }
```

To apply the default and `special` flavors in the previous example, add a `.flavors` file to an application bundle. The next example adds flavors specified in `ui-buttonFlcavors.css` to all `ui:button` component instances in an application.

```
<!-- myApp.flavors -->
<aura:flavors>
  <aura:include source="sample:flavors"/>
</aura:flavors>
```

In this case, the default flavor of button will now be green, without affecting the `text-shadow` rule in the original flavor. By adding the `.flavors` file to the application bundle, the `special` flavor is now available for the component.

Styling with Tokens

Tokens make it easy to ensure that your design is consistent, and even easier to update it as your design evolves. Define the token values once and reuse them throughout your Aura applications.

There are two types of tokens: design tokens and configuration tokens.

Design Tokens

Design tokens are visual design “atoms” for building a design for your components or apps. Specifically, they’re named entities that store visual design attributes, such as pixel values for margins and spacing, font sizes and families, or hex values for colors. Use design tokens in CSS.

Capture the essential values of your visual design into named tokens. Tokens are a terrific way to centralize the low-level values, which you then use to compose the styles that make up the design of your component or app.

Configuration Tokens

Use configuration tokens in expressions, such as in component markup, for cross-cutting application values that remain consistent across all components in your app. A typical use case for configuration tokens is in a markup expression setting a class name.

It’s a best practice to separate design tokens and configuration tokens into separate tokens bundles. However, the separation isn’t enforced so you have freedom to create a token structure that works for you.

IN THIS SECTION:

Tokens Bundles

Tokens are a type of bundle, just like components, events, and interfaces. A tokens bundle only contains a tokens file.

CSS Tokens Bundle for a Namespace

The tokens file for a namespace is automatically loaded for usage in CSS if it follows this file naming convention:

`<myNamespace>/<myNamespace>Namespace/<myNamespace>Namespace.tokens`

That's a little confusing. Let's look at an example with the `docsample` namespace. The CSS tokens file is located at:

`aura-components/components/docsample/docsampleNamespace/docsampleNamespace.tokens`

If this file exists, the tokens can be used in any CSS files in the `docsample` namespace.

Custom Tokens Bundles

You can have multiple token bundles and you can name them whatever you want. You must manually wire up your custom token files.

You might want a custom tokens bundle for an application so that you can use tokens in markup or other expressions. For example:

`aura-components/components/docsample/myApp/myApp.tokens`

Wire up the custom tokens file in your application by using the `tokens` attribute in your `<aura:application>` tag:

```
<aura:application tokens="docsample:myApp">
    …
</aura:application>
```

Use comma-separated values for multiple tokens files. The naming convention for automatically loading tokens for a namespace is required for tokens in CSS, but can be augmented or overridden by using explicit token files. To use tokens in markup, you must explicitly set the tokens file in the `tokens` attribute. For example:

```
<aura:application tokens="docsample:myApp,docsample:docsampleNamespace">
    …
</aura:application>
```

Defining Tokens

A token is a name-value pair that you specify using the `<aura:token>` tag. A tokens file contains one or more tokens.

A tokens file starts with the `<aura:tokens>` tag. It can only contain `<aura:token>` tags to define tokens. The only allowed attributes for the `<aura:token>` tag are `name` and `value`.

For example:

```
<aura:tokens>
    <aura:token name="myBodyTextFontFace"
        value="'Helvetica, Arial, sans-serif"/>
    <aura:token name="myBodyTextFontWeight" value="normal"/>
    <aura:token name="myBackgroundColor" value="#f4f6f9"/>
    <aura:token name="myDefaultMargin" value="6px"/>
</aura:tokens>
```

IN THIS SECTION:

Using Expressions in Tokens Bundles
Tokens support a restricted set of expressions. Use expressions to reuse one token value in another token, or to combine tokens to form a more complex style property.

Using Expressions in Tokens Bundles

Tokens support a restricted set of expressions. Use expressions to reuse one token value in another token, or to combine tokens to form a more complex style property.

Cross-Referencing Tokens

To reference one token's value in another token's definition, wrap the token to be referenced in standard expression syntax.

In the following example, we look at two tokens files. `baseApp.tokens` defines some tokens. `extendApp.tokens` extends `baseApp.tokens` and uses expressions to reference the tokens from `baseApp.tokens`.

```
<!-- baseApp.tokens -->
<aura:tokens>
    ...
    <aura:token name="colorBackground" value="rgb(244, 246, 249)" />
    <aura:token name="fontFamily" value="'Salesforce Sans', Arial, sans-serif" />
```

```
  ...
</aura:tokens>
```

You can reference the tokens from `baseApp.tokens` in `extendApp.tokens`.

```
<!-- extendApp.tokens -->
<aura:tokens extends="docsample:baseApp">
    <aura:token name="mainColor" value="{! colorBackground }" />
    <aura:token name="btnColor" value="{! mainColor }" />
    <aura:token name="myFont" value="{! fontFamily }" />
</aura:tokens>
```

The `mainColor` token in `extendApp.tokens` uses an expression to reference the `colorBackground` token in `baseApp.tokens`.

You can only cross-reference tokens defined in the same file or a file you're extending.

Expression syntax in tokens files is restricted to references to other tokens.

Combining Tokens

To support combining individual token values into more complex CSS style properties, the `token()` function supports string concatenation. For example, if you have the following tokens defined:

```
<!-- myApp.tokens -->
<aura:tokens>
    <aura:token name="defaultHorizonalSpacing" value="12px" />
    <aura:token name="defaultVerticalSpacing" value="6px" />
</aura:tokens>
```

You can combine these two tokens in a CSS style definition. For example:

```
/* myComponent.css */
.THIS div.notification {
  margin: token(defaultVerticalSpacing + ' ' + defaultHorizonalSpacing);
  /* more styles here */
}
```

You can mix tokens with strings as much as necessary to create the right style definition. For example, use `margin: token(defaultVerticalSpacing + ' ' + defaultHorizonalSpacing + ' 3px');` to hard code the bottom spacing in the preceding definition.

The only operator supported within the `token()` function is "+" for string concatenation.

SEE ALSO:

Using Expressions

Using Design Tokens in CSS

Use tokens in your component's CSS for consistent styling across all components in your app.

To use a design token in a CSS file, reference it using the `token(`***`tokenName`***`)` function. For example:

```
.THIS p {
    font-family: token(myBodyTextFontFace);
```

```
    font-weight: token(myBodyTextFontWeight);
}
```

`myBodyTextFontFace` corresponds to the `name` attribute in an `<aura:token>` definition. The `token(myBodyTextFontFace)` function is replaced by the value in the `<aura:token>` definition.

If you prefer a more concise function name for referencing tokens, you can use the `t()` function instead of `token()`. The two are equivalent.

SEE ALSO:

CSS in Components

Using Configuration Tokens in Expressions

Use configuration tokens in expressions, such as in component markup, for cross-cutting application values that remain consistent across all components in your app. A typical use case for configuration tokens is in a markup expression setting a class name.

To use a token in markup, reference it using the `token('`***`tokenName`***`')` function. Note the single quotes around the token name. This syntax differs from CSS usage where there are no single quotes around the token name.

For example:

```
<ui:label class="{!token('labelClass')}" />
```

`labelClass` corresponds to the `name` attribute in an `<aura:token>` definition.

Note: To use a token in an expression:

- The `<aura:tokens>` tag in the tokens bundle containing the token must set the attribute `serialize="true"`. This isn't necessary for token usage in CSS as the CSS is parsed on the server before being serialized to the client. For example:

```
<aura:tokens serialize="true">
    <aura:token name="labelClass"  value="'sampleClass"/>
</aura:tokens>
```

- The `<aura:application>` tag must use the `tokens` attribute to point to the tokens bundle. For example:

```
<aura:application tokens="docsample:docsampleNamespace">
```

Let's look at a complete sample. The `docsample/docsampleNamespace/docsampleNamespace.tokens` file defines a few tokens.

```
<aura:tokens serialize="true">
    <aura:token name="myBackgroundColor" value="#ff0000"/>
    <aura:token name="other" value="notFirst"/>
</aura:tokens>
```

We'll see how these tokens are used soon in CSS and markup. Notice that the `<aura:tokens>` tag sets `serialize="true"`.

The `docsample:tokensUsage` component includes the `{!token('other')}` tag to reference the `other` token.

```
<!--docsample:tokensUsage-->
<aura:component>
    <div class="white">
    Hello, HTML!
    </div>
```

```
    <h2>Check out the style in this list.</h2>
    <ul>
        <li class="first">I'm first.</li>
        <li class="{!token('other')}">I'm second.</li>
        <!--<li class="notFirst">I'm second.</li>-->
        <li>I'm third.</li>
    </ul>
</aura:component>
```

`<li class="{!token('other')}">I'm second.</li>` uses a token instead of the hard-coded equivalent that is commented out:

```
<!--<li class="notFirst">I'm second.</li>-->
```

Here is the CSS.

```
/* docsample/tokensUsage.css*/
.THIS {
    background-color: grey;
}
.THIS.white {
    background-color: white;
}
.THIS .first {
    background-color: token(myBackgroundColor);
}
.THIS .notFirst {
    background-color: blue;
}
```

The `.THIS .first` selector uses `token(myBackgroundColor)` to set the background color for a list item in the markup. `myBackgroundColor` is set to `#ff0000` in `docsampleNamespace.tokens`.

```
<li class="first">I'm first.</li>
```

The second list item in the markup uses the `other` token.

```
<li class="{!token('other')}">I'm second.</li>
```

The value of the `other` token is set in `docsampleNamespace.tokens`.

```
<aura:token name="other" value="notFirst"/>
```

The `.THIS .notFirst` CSS selector sets the background color for this list item to blue.

Finally, let's look at the app that loads the tokens file.

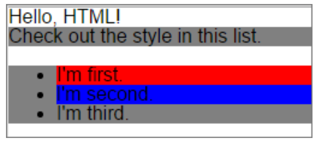
```
<!--docsample:wrapperApp-->
<aura:application tokens="docsample:docsampleNamespace">
    <docsample:tokensUsage />
</aura:application>
```

The `tokens` attribute loads the tokens file at `docsample/docsampleNamespace/docsampleNamespace.tokens`.

After starting your server, navigate to the app at:

`http://localhost:<port>/docsample/wrapperApp.app`

The output should look like this.



SEE ALSO:

Using Expressions

Defining Tokens

CHAPTER 7 Developing Secure Code

In this chapter ...

The Locker Service architectural layer enhances security by isolating individual Lightning components in their own containers and enforcing coding best practices.

What is Locker Service?

Locker Service is a powerful security architecture for Lightning components. Locker Service enhances security by isolating Lightning components in their own namespace. Locker Service also promotes best practices that improve the supportability of your code by only allowing access to supported APIs and eliminating access to non-published framework internals.

IN THIS SECTION:

JavaScript ES5 Strict Mode Enforcement

Locker Service implicitly enables JavaScript ES5 strict mode. You don't need to specify `"use strict"` in your code. JavaScript strict mode makes code more robust and supportable. For example, it throws some errors that would otherwise be suppressed.

A few common stumbling points when using strict mode are:

- You must declare variables with the `var` keyword.
- You must explicitly attach a variable to the `window` object to make the variable available outside a library.
- The libraries that your components use must also work in strict mode.

For more information about JavaScript strict mode, see the Mozilla Developer Network.

DOM Access Containment

A component can only traverse the DOM and access elements created by a component in the same namespace. This behavior prevents the anti-pattern of reaching into DOM elements owned by components in another namespace.

Note: It's an anti-pattern for any component to "reach into" another component, regardless of namespace. Locker Service only prevents cross-namespace access. Your good judgment should prevent cross-component access within your own namespace as it makes components tightly coupled and more likely to break.

Let's look at a sample component that demonstrates DOM containment.

```
<!--c:domLocker-->
<aura:component>
    <div id="myDiv" aura:id="div1">
        <p>See how Locker Service restricts DOM access</p>
    </div>
    <lightning:button name="myButton" label="Peek in DOM"
                aura:id="button1" onclick="{!c.peekInDom}"/>
</aura:component>
```

The `c:domLocker` component creates a `<div>` element and a `<lightning:button>` component.

Here's the client-side controller that peeks around in the DOM.

```
({ /* domLockerController.js */
    peekInDom : function(cmp, event, helper) {
        console.log("cmp.getElements(): ", cmp.getElements());
        // access the DOM in c:domLocker
        console.log("div1: ", cmp.find("div1").getElement());
        console.log("button1: ", cmp.find("button1"));
        console.log("button name: ", event.getSource().get("v.name"));

        // returns an error
        //console.log("button1 element: ", cmp.find("button1").getElement());
    }
})
```

Valid DOM Access

The following methods are valid DOM access because the elements are created by `c:domLocker`.

`cmp.getElements()`
: Returns the elements in the DOM rendered by the component.

`cmp.find()`
: Returns the div and button components, identified by their `aura:id` attributes.

`cmp.find("div1").getElement()`
: Returns the DOM element for the div as `c:domLocker` created the div.

`event.getSource().get("v.name")`
: Returns the name of the button that dispatched the event; in this case, `myButton`.

Invalid DOM Access

You can't use `cmp.find("button1").getElement()` to access the DOM element created by `<lightning:button>`. Locker Service doesn't allow `c:domLocker` to access the DOM for `<lightning:button>` because the button is in the `lightning` namespace and `c:domLocker` is in the `c` namespace.

If you uncomment the code for `cmp.find("button1").getElement()`, you'll see an error:

```
c:domLocker$controller$peekInDom [cmp.find(...).getElement is not a function]
```

IN THIS SECTION:

How Locker Service Uses the `Proxy` Object

Locker Service uses the standard JavaScript `Proxy` object to filter a component's access to underlying JavaScript objects. The `Proxy` object ensures that a component only sees DOM elements created by a component in the same namespace.

You can interact with a `Proxy` object in the same way as you interact with the raw JavaScript object, but the object shows up in the browser's console as a `Proxy`. It's useful to understand Locker Service's usage of `Proxy` if you drop into your browser's debugger and start poking around.

When a component creates an intrinsic JavaScript object, Locker Service returns the raw JavaScript object. When Locker Service filters the object, it returns a `Proxy` object. Some scenarios where Locker Service filters an object and returns a `Proxy` object are:

- Passing an object to a component in a different namespace.
- Passing an object from a component on API version less than 40.0 to the method of a component on API version greater than or equal to 40.0.
- Calling `cmp.get()` to retrieve an attribute value that you set with the value of a native JavaScript object or array. The object or array isn't filtered when it's originally created.

When you access these objects, Locker Service returns a `Proxy` object.

- Any object that implements the HTMLCollection interface
- A `SecureElement` object, which represents an HTML element.

For more information about standard JavaScript `Proxy` object, see the Mozilla Developer Network.

Secure Wrappers for Global References

Locker Service applies restrictions to global references. Locker Service provides secure versions of non-intrinsic objects, such as `window`. For example, the secure version of `window` is `SecureWindow`. You can interact with a secure wrapper in the same way as you interact with the non-intrinsic object, but the secure wrappers filter access to the object and its properties. The secure wrappers expose a subset of the API of the underlying objects.

Here's a list of the secure objects that you most commonly encounter.

`SecureAura`

Secure wrapper for `$A`, which is the entry point for using the framework in JavaScript code.

`SecureComponent`

Secure wrapper for the `Component` object.

`SecureComponentRef`

`SecureComponentRef` is a subset of `SecureComponent` that provides the external API for a component in a different namespace.

When you're in a controller or helper, you have access to a `SecureComponent`, essentially the `this` object. In other contexts when you're working with a component, you get a `SecureComponentRef` instead if you reference a component in a different namespace. For example, if your markup includes a `lightning:button` and you call `cmp.find("buttonAuraId")`, you get a `SecureComponentRef` as `lightning:button` is in a different namespace from the component containing the button markup.

SecureDocument

Secure wrapper for the `document` object, which represents the root node of the HTML document or page. The `document` object is the entry point into the page's content, which is the DOM tree.

SecureElement

Secure wrapper for the `Element` object, which represents an HTML element. `SecureElement` is wrapped in a `Proxy` object as a performance optimization so that its data can be lazily filtered when it's accessed. The HTML element is represented by a Proxy object if you're debugging in the browser console.

SecureObject

Secure wrapper for an object that is wrapped by Locker Service. When you see a `SecureObject`, it typically means that you don't have access to the object so some properties aren't available.

SecureWindow

Secure wrapper for the `window` object, which represents a window containing a DOM document.

Example

Let's look at a sample component that demonstrates some of the secure wrappers.

```
<!--c:secureWrappers-->
<aura:component >
    <div id="myDiv" aura:id="div1">
        <p>See how Locker Service uses secure wrappers</p>
    </div>
    <lightning:button name="myButton" label="Peek in DOM"
        aura:id="button1" onclick="{!c.peekInDom}"/>
</aura:component>
```

The `c:secureWrappers` component creates a `<div>` HTML element and a `<lightning:button>` component.

Here's the client-side controller that peeks around in the DOM.

```
({ /* secureWrappersController.js */
    peekInDom : function(cmp, event, helper) {
        console.log("div1: ", cmp.find("div1").getElement());

        console.log("button1: ", cmp.find("button1"));
        console.log("button name: ", event.getSource().get("v.name"));
        // add debugger statement for inspection
        // always remove this from production code
        debugger;
    }
})
```

We use `console.log()` to look at the `<div>` element and the button. The `<div>` `SecureElement` is wrapped in a `Proxy` object as a performance optimization so that its data can be lazily filtered when it's accessed.

We put a debugger statement in the code so that we could inspect the elements in the browser console.

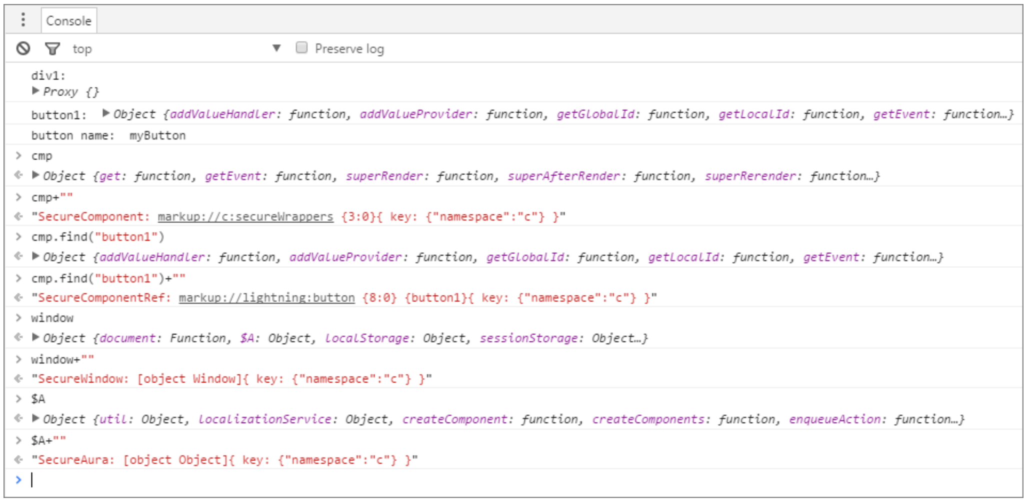
Type these expressions into the browser console and look at the results.

```
cmp
cmp+""
cmp.find("button1")
cmp.find("button1")+""
window
```

```
window+""
$A
$A+""
```

We add an empty string to some expressions so that the object is converted to a `String`. You could also use the `toString()` method.

Here's the output.



Let's examine some of the output.

`cmp+""`
: Returns a `SecureComponent` object for `cmp`, which represents the `c:secureWrappers` component.

`cmp.find("button1")+""`
: Returns a `SecureComponentRef`, which represents the external API for a component in a different namespace. In this example, the component is `lightning:button`.

`window+""`
: Returns a `SecureWindow` object.

`$A+""`
: Returns a `SecureAura` object.

IN THIS SECTION:

[JavaScript API for Secure Wrappers](#)
The secure wrappers, such as `SecureWindow`, expose a subset of the API of the objects that they wrap. The API for the secure wrappers is documented in the Locker Service API Viewer app or the reference doc app.

SEE ALSO:

How Locker Service Uses the Proxy Object

JavaScript API for Secure Wrappers

The secure wrappers, such as `SecureWindow`, expose a subset of the API of the objects that they wrap. The API for the secure wrappers is documented in the Locker Service API Viewer app or the reference doc app.

Locker Service API Viewer

The Locker Service API Viewer shows the DOM APIs exposed by Locker Service versus the standard DOM APIs. The API Viewer app lists the API for `SecureDocument`, `SecureElement`, and `SecureWindow`.

The API Viewer lets you quickly see the difference between the standard DOM APIs and the Locker Service APIs.

- An **orange** row indicates an API that behaves differently in Locker Service.
- A **red** row means the API isn't supported in Locker Service.

Reference Doc App

The reference doc app lists the API for `SecureComponent` under **JavaScript API** > **Component**.

`SecureAura` is the wrapper for `$A`.

SEE ALSO:

Secure Wrappers for Global References

Access to Supported JavaScript API Framework Methods Only

You can access published, supported JavaScript API framework methods only. These methods are published in the reference doc app at `http://<myServer>/auradocs/reference.app`. Previously, unsupported methods were accessible, which exposed your code to the risk of breaking when unsupported methods were changed or removed.

CHAPTER 8 Using JavaScript

In this chapter ...

Use JavaScript for client-side code. The `$A` namespace is the entry point for using the framework in JavaScript code.

For all the methods available in `$A`, see the JavaScript API.

A component bundle can contain JavaScript code in a client-side controller, renderer, helper, or test file. Client-side controllers are the most commonly used of these JavaScript files.

Publicly Accessible JavaScript Methods

The JavaScript API Reference lists the methods for each JavaScript object. When you are writing code, it's important to understand which methods are publicly accessible for a JavaScript object.

A publicly accessible method is annotated with `@export`. Any method that doesn't have an `@export` annotation is for internal use by the framework.

Expressions in JavaScript Code

In JavaScript, use string syntax to evaluate an expression. For example, this expression retrieves the `label` attribute in a component.

```
var theLabel = cmp.get("v.label");
```

Note: Only use the `{! }` expression syntax in markup in `.app` or `.cmp` files.

SEE ALSO:

Handling Events with Client-Side Controllers

Invoking Actions on Component Initialization

Use the `init` event to initialize a component or fire an event after component construction but before rendering.

If a component is contained in another component or app, the inner component is initialized first.

Let's look at an example.

Component source

```
<aura:component>
    <aura:attribute name="setMeOnInit" type="String" default="default value" />
    <aura:handler name="init" value="{!this}" action="{!c.doInit}"/>

    <p>This value is set in the controller after the component initializes and before
rendering.</p>
    <p><b>{!v.setMeOnInit}</b></p>

</aura:component>
```

Client-side controller source

```
({
    doInit: function(cmp) {
        // Set the attribute value.
        // You could also fire an event here instead.
        cmp.set("v.setMeOnInit", "controller init magic!");
    }
})
```

Let's look at the **Component source** to see how this works. The magic happens in this line.

```
<aura:handler name="init" value="{!this}" action="{!c.doInit}"/>
```

This registers an `init` event handler for the component. `init` is a predefined event sent to every component. After the component is initialized, the `doInit` action is called in the component's controller. In this sample, the controller action sets an attribute value, but it could do something more interesting, such as firing an event.

Note: You should never fire an event in a renderer so using the `init` event is a good alternative for many scenarios.

Setting `value="{!this}"` marks this as a value event. You should always use this setting for an `init` event.

SEE ALSO:

Handling Events with Client-Side Controllers
Create a Custom Renderer
Component Attributes
Detecting Data Changes with Change Handlers

Sharing JavaScript Code in a Component Bundle

Put functions that you want to reuse in the component's helper. Helper functions also enable specialization of tasks, such as processing data and firing server-side actions.

A helper function can be called from any JavaScript code in a component's bundle, such as from a client-side controller or renderer.

Helper functions are similar to client-side controller functions in shape, surrounded by parentheses and curly braces to denote a JavaScript object in object-literal notation containing a map of name-value pairs. A helper function can pass in any arguments required by the function, such as the component it belongs to, a callback, or any other objects.

```
({
    helperMethod1 : function() {
        // logic here
    },

    helperMethod2 : function(component) {
        // logic here
        this.helperMethod3(var1, var2);
    },

     helperMethod3 : function(var1, var2) {
         // do something with var1 and var2 here
    }
})
```

Creating a Helper

A helper file is part of the component bundle and is auto-wired via the naming convention, `<componentName>Helper.js`.

Note: If you want to call the same methods from multiple components, put the shared methods in a JavaScript library. A helper allows you to only share methods within one component bundle.

Using a Helper in a Controller

Add a `helper` argument to a controller function to enable the function to use the helper. Specify `(component, event, helper)` in the controller. These are standard parameters and you don't have to access them in the function. You can also pass in an instance variable as a parameter, for example, `createExpense: function(component, expense){...}`, where `expense` is a variable defined in the component.

The following code shows you how to call the `updateItem` helper function in a controller, which can be used with a custom event handler.

```
/* controller */
({
    newItemEvent: function(component, event, helper) {
        helper.updateItem(component, event.getParam("item"));
    }
})
```

Helper functions are local to a component, improve code reuse, and move the heavy lifting of JavaScript logic away from the client-side controller where possible. The following code shows the helper function, which takes in the `value` parameter set in the controller via the `item` argument. The code walks through calling a server-side action and returning a callback but you can do something else in the helper function.

```
/* helper */
({
    updateItem : function(component, item, callback) {
        //Update the items via a server-side action
        var action = component.get("c.saveItem");
```

```
        action.setParams({"item" : item});
        //Set any optional callback and enqueue the action
        if (callback) {
            action.setCallback(this, callback);
        }
        $A.enqueueAction(action);
    }
})
```

Using a Helper in a Renderer

Add a helper argument to a renderer function to enable the function to use the helper. In the renderer, specify `(component, helper)` as parameters in a function signature to enable the function to access the component's helper. These are standard parameters and you don't have to access them in the function. The following code shows an example on how you can override the `afterRender()` function in the renderer and call `open` in the helper method.

detailsRenderer.js

```
({
    afterRender : function(component, helper){
        helper.open(component, null, "new");
    }
})
```

detailsHelper.js

```
({
    open : function(component, note, mode, sort){
        if(mode === "new") {
            //do something
        }
        // do something else, such as firing an event
    }
})
```

SEE ALSO:

Create a Custom Renderer

Component Bundles

Handling Events with Client-Side Controllers

Using External JavaScript Libraries

To use an external JavaScript library in your apps, include a `<script>` tag in your `.app` file or include it in your app's template.

SEE ALSO:

Creating App Templates

aura:application

Creating Reusable JavaScript Libraries

An Aura JavaScript library enables you to create a set of JavaScript files that can be used by any component that imports the library.

Creating a Library

Every library lives in a namespace and follows a naming convention. The `c:myLib` library points to a library in `c/myLib/myLib.lib`.

A library is defined in a `.lib` file that starts with the `<aura:library>` tag. A library includes an arbitrary number of JavaScript files. Each file is defined with an `<aura:include>` tag.

For example, this `myLib.lib` library includes three files.

```
<aura:library description="A set of global services">
    <aura:include name="ViewService" />
    <aura:include name="ErrorService" />
    <aura:include name="LogService" imports="ErrorService"/>
</aura:library>
```

The `name` attribute of `<aura:include>` is the name of the JavaScript file with or without the `.js` suffix. For example, `name="ViewService"` or `name="ViewService.js"` points to `c/myLib/ViewService.js`.

Note: The `name` attribute can only contain letters, numbers, dot, dash, and underscore characters and must start with a letter or underscore.

The `imports` attribute of `<aura:include>` specifies another JavaScript file that is referenced and imported in the included file. For example, this import specifies that `LogService.js` uses code in `ErrorService.js`.

```
<aura:include name="LogService" imports="ErrorService"/>
```

This example imports an `OtherErrorService` file that is used in a different library, `othernamespace:otherLibrary`.

```
<aura:include name="LogService"
        imports="othernamespace:otherLibrary:OtherErrorService"/>
```

Use a comma-separated list to import more than one JavaScript file. This example imports multiple files.

```
<aura:include name="LogService" imports="ErrorService,BaseLogService"/>
```

Importing a Library

Use the `<aura:import>` tag in a component's markup to import a library and enable usage of the library in the component's JavaScript files.

This markup imports the `c:myLib` library.

```
<aura:import library="c:myLib" property="BaseServices" />
```

The `property` attribute of `<aura:import>` is the variable name that can be used in the component's helper to reference the library.

Using a Library

You can reference the library in the helper of the component that imports the library by using the `property` attribute.

To reference one of the JavaScript files from the library in the helper, use this syntax:

```
var includedFile = this.<property>.<name>;
```

where `<property>` is defined by the `<aura:import>` tag, and `<name>` is defined by the `<aura:include>` tag. For example:

```
var ViewService = this.BaseServices.ViewService;
```

`BaseServices` is the `property` value defined in the `<aura:import>` tag.

To reference a library file in the controller, use this syntax:

```
var ViewService = helper.BaseServices.ViewService;
```

Format of Library Files

This type of library is for libraries stored locally on your filesystem. For external JavaScript libraries, see Using External JavaScript Libraries instead.

Each file in a library must be a function and use a module pattern. The return value of the function is the singleton instance that is bound to the helper of a component that imports the library.

For example, let's look at a sample `ViewService.js` file that imports the `ErrorService.js` and `BaseLogService.js` files.

```
<aura:include name="LogService" imports="ErrorService,BaseLogService" />
```

Here is `ViewService.js`:

```
function(ErrorService, BaseLogService) {
    return {
        getView: function() {
            ...
        }
    }
}
```

Note how the imported `ErrorService.js` and `BaseLogService.js` files are set as parameters in the opening function.

if you want to name the function parameters differently, you can configure aliases. For example:

```
<aura:include name="LogService" imports="ErrorService,BaseLogService"
    aliases="es,bls" />
```

Here is `ViewService.js` using the aliases:

```
function(es, bls) {
    return {
        getView: function() {
            ...
        }
    }
}
```

The `aliases` are variables available in the lexical scope of the module and correspond one-to-one to the list of `imports`.

You can call the `getView()` function in a helper using this syntax:

```
var view = this.BaseServices.ViewService.getView();
```

Shim for Library Files

What if you have a library file that doesn't match the required format where each file must be a function? The framework can create a shim to wrap a file in the required format. The shim enables you to use third-party code without having to modify it, which makes maintenance and upgrades easier.

For example, if you have a local copy of the Backbone library, you can create a file to manually wrap the code.

```
function($, _) {
    // Original backbone code
    return Backbone;
}
```

A better approach is to let the framework create the shim to wrap it in the required format.

```
<aura:include name="Backbone" imports="jQuery, Underscore"
    aliases="$, _" export="Backbone"/>
```

The `export` attribute corresponds to the variable that exists in the lexical scope that you use in your helper.

Dynamically Creating Components

Create a component dynamically in your client-side JavaScript code by using the `$A.createComponent()` method. To create multiple components, use `$A.createComponents()`.

Note: Use `$A.createComponent()` instead of the deprecated `newComponent()`, `newComponentAsync()`, and `newComponentDeprecated()` methods of `AuraComponentService` or the deprecated `newCmp()` and `newCmpAsync()` methods of `$A`.

The syntax is:

```
$A.createComponent(String type, Object attributes, function callback)
```

1. `type`—The type of component to create; for example, `"ui:button"`.
2. `attributes`—A map of attributes for the component, including the local Id (`aura:id`) and flavor (`aura:flavor`).
3. `callback(cmp, status, errorMessage)`—The callback to invoke after the component is created. The callback has three parameters.
    a. `cmp`—The component that was created. This enables you to do something with the new component, such as add it to the body of the component that creates it. If there's an error, `cmp` is `null`.
    b. `status`—The status of the call. The possible values are `SUCCESS`, `INCOMPLETE`, or `ERROR`. Always check that the status is `SUCCESS` before you try to use the component.
    c. `errorMessage`—The error message if the status is `ERROR`.

Let's add a dynamically created button to this sample component.

```
<!--c:createComponent-->
<aura:component>
    <aura:handler name="init" value="{!this}" action="{!c.doInit}"/>
```

```
    <p>Dynamically created button</p>
    {!v.body}
</aura:component>
```

The client-side controller calls `$A.createComponent()` to create a `ui:button` with a local ID and a handler for the `onclick` attribute. The `function(newButton, ...)` callback appends the button to the `body` of `c:createComponent`. The `newButton` that's dynamically created by `$A.createComponent()` is passed as the first argument to the callback.

```
/*createComponentController.js*/
({
    doInit : function(cmp) {
        $A.createComponent(
            "lightning:button",
            {
                "aura:id": "findableAuraId",
                "label": "Press Me",
                "onclick": cmp.getReference("c.handlePress")
            },
            function(newButton, status, errorMessage){
                //Add the new button to the body array
                if (status === "SUCCESS") {
                    var body = cmp.get("v.body");
                    body.push(newButton);
                    cmp.set("v.body", body);
                }
                else if (status === "INCOMPLETE") {
                    console.log("No response from server or client is offline.")
                    // Show offline error
                }
                else if (status === "ERROR") {
                    console.log("Error: " + errorMessage);
                    // Show error message
                }
            }
        );
    },

    handlePress : function(cmp) {
        // Find the button by the aura:id value
        console.log("button: " + cmp.find("findableAuraId"));
        console.log("button pressed");
    }
})
```

Note: `c:createComponent` contains a `{!v.body}` expression. When you use `cmp.set("v.body", ...)` to set the component body, you must explicitly include `{!v.body}` in your component markup.

Creating Nested Components

To dynamically create a component in the body of another component, use `$A.createComponents()` to create the components. In the function callback, nest the components by setting the inner component in the `body` of the outer component. This example creates a `ui:outputText` component in the `body` of a `ui:message` component.

```
$A.createComponents([
    ["ui:message",{
        "title" : "Sample Thrown Error",
        "severity" : "error",
    }],
    ["ui:outputText",{
        "value" : e.message
    }]
    ],
    function(components, status, errorMessage){
        if (status === "SUCCESS") {
            var message = components[0];
            var outputText = components[1];
            // set the body of the ui:message to be the ui:outputText
            message.set("v.body", outputText);
        }
        else if (status === "INCOMPLETE") {
            console.log("No response from server or client is offline.")
            // Show offline error
        }
        else if (status === "ERROR") {
            console.log("Error: " + errorMessage);
            // Show error message
        }
    }
);
```

Destroying Dynamically Created Components

After a component that is declared in markup is no longer in use, the framework automatically destroys it and frees up its memory.

If you create a component dynamically in JavaScript and that component isn't added to a facet (`v.body` or another attribute of type `Aura.Component[]`), you have to destroy it manually using `Component.destroy()` to avoid memory leaks.

Avoiding a Server Trip

The `createComponent()` and `createComponents()` methods support both client-side and server-side component creation. For performance and other reasons, client-side creation is preferred. If no server-side dependencies are found, the methods are executed client-side. The top-level component determines whether a server request is necessary for component creation.

The framework automatically tracks dependencies between definitions, such as components, defined in markup. These dependencies are loaded with the component. However, some dependencies aren't easily discoverable by the framework; for example, if you dynamically create a component that isn't directly referenced in the component's markup. To tell the framework about such a dynamic dependency, use the `<aura:dependency>` tag. This declaration ensures that the component *and its dependencies* are sent to the client.

A component with server-side dependencies must be created on the server. Server-side dependencies include server-side models, renderers, or providers for the component and its super components. Using any server-side models for the component and its super components is a server-side dependency.

Note: A server-side controller isn't a server-side dependency for component creation because controller actions are only called after the component has been created.

A single call to `createComponent()` or `createComponents()` can result in many components being created. The call creates the requested component and all its child components. In addition to performance considerations, server-side component creation has a limit of 10,000 components that can be created in a single request. If you hit this limit, ensure you're explicitly declaring component dependencies with the `<aura:dependency>` tag or otherwise pre-loading dependent elements, so that your component can be created on the client side instead.

There's no limit on component creation on the client side.

Note: Creating components where the top-level components don't have server dependencies but nested inner components do isn't currently supported.

SEE ALSO:

- Reference Doc App
- aura:dependency
- Invoking Actions on Component Initialization
- Dynamically Adding Event Handlers To a Component
- Styling with Flavors

Detecting Data Changes with Change Handlers

Configure a component to automatically invoke a change handler, which is a client-side controller action, when a value in one of the component's attributes changes.

When the value changes, the `valueChange.evt` event is automatically fired. The event has `type="VALUE"`.

In the component, define a handler with `name="change"`.

```
<aura:handler name="change" value="{!v.numItems}" action="{!c.itemsChange}"/>
```

The `value` attribute sets the component attribute that the change handler tracks.

The `action` attribute sets the client-side controller action to invoke when the attribute value changes.

A component can have multiple `<aura:handler name="change">` tags to detect changes to different attributes.

In the controller, define the action for the handler.

```
({
    itemsChange: function(cmp, evt) {
        console.log("numItems has changed");
        console.log("old value: " + evt.getParam("oldValue"));
        console.log("current value: " + evt.getParam("value"));
    }
})
```

The `valueChange` event gives you access to the previous value (`oldValue`) and the current value (`value`) in the handler action.

When a change occurs to a value that is represented by the `change` handler, the framework handles the firing of the event and rerendering of the component.

SEE ALSO:

Invoking Actions on Component Initialization

Finding Components by ID

Retrieve a component by its ID in JavaScript code.

Use `aura:id` to add a local ID of `button1` to the `lightning:button` component.

```
<lightning:button aura:id="button1" label="button1"/>
```

You can find the component by calling `cmp.find("button1")`, where `cmp` is a reference to the component containing the button. The `find()` function has one parameter, which is the local ID of a component within the markup.

`find()` returns different types depending on the result.

- If the local ID is unique, `find()` returns the component.
- If there are multiple components with the same local ID, `find()` returns an array of the components.
- If there is no matching local ID, `find()` returns `undefined`.

SEE ALSO:

Component IDs

Value Providers

Working with Attribute Values in JavaScript

These are useful and common patterns for working with attribute values in JavaScript.

`component.get(String key)` and `component.set(String key, Object value)` retrieves and assigns values associated with the specified key on the component. Keys are passed in as an expression, which represents attribute values. To retrieve an attribute value of a component reference, use `component.find("cmpId").get("v.value")`. Similarly, use `component.find("cmpId").set("v.value", myValue)` to set the attribute value of a component reference. This example shows how you can retrieve and set attribute values on a component reference, represented by the button with an ID of `button1`.

```
<aura:component>
    <aura:attribute name="buttonLabel" type="String"/>
    <lightning:button aura:id="button1" label="Button 1"/>
    {!v.buttonLabel}
    <lightning:button label="Get Label" onclick="{!c.getLabel}"/>
</aura:component>
```

This controller action retrieves the `label` attribute value of a button in a component and sets its value on the `buttonLabel` attribute.

```
({
    getLabel : function(component, event, helper) {
        var myLabel = component.find("button1").get("v.label");
```

```
        component.set("v.buttonLabel", myLabel);
    }
})
```

In the following examples, `cmp` is a reference to a component in your JavaScript code.

Get an Attribute Value

To get the value of a component's `label` attribute:

```
var label = cmp.get("v.label");
```

Set an Attribute Value

To set the value of a component's `label` attribute:

```
cmp.set("v.label","This is a label");
```

Validate that an Attribute Value is Defined

To determine if a component's `label` attribute is defined:

```
var isDefined = !$A.util.isUndefined(cmp.get("v.label"));
```

Validate that an Attribute Value is Empty

To determine if a component's `label` attribute is empty:

```
var isEmpty = $A.util.isEmpty(cmp.get("v.label"));
```

SEE ALSO:

Accessing Models in JavaScript

Working with a Component Body in JavaScript

Working with a Component Body in JavaScript

These are useful and common patterns for working with a component's body in JavaScript.

In these examples, `cmp` is a reference to a component in your JavaScript code. It's usually easy to get a reference to a component in JavaScript code. Remember that the `body` attribute is an array of components, so you can use the JavaScript `Array` methods on it.

Note: When you use `cmp.set("v.body", ...)` to set the component body, you must explicitly include `{!v.body}` in your component markup.

Replace a Component's Body

To replace the current value of a component's body with another component:

```
// newCmp is a reference to another component
cmp.set("v.body", newCmp);
```

Clear a Component's Body

To clear or empty the current value of a component's body:

```
cmp.set("v.body", []);
```

Append a Component to a Component's Body

To append a `newCmp` component to a component's body:

```
var body = cmp.get("v.body");
// newCmp is a reference to another component
body.push(newCmp);
cmp.set("v.body", body);
```

Prepend a Component to a Component's Body

To prepend a `newCmp` component to a component's body:

```
var body = cmp.get("v.body");
body.unshift(newCmp);
cmp.set("v.body", body);
```

Remove a Component from a Component's Body

To remove an indexed entry from a component's body:

```
var body = cmp.get("v.body");
// Index (3) is zero-based so remove the fourth component in the body
body.splice(3, 1);
cmp.set("v.body", body);
```

SEE ALSO:

Component Body

Working with Attribute Values in JavaScript

Working with Events in JavaScript

These are useful and common patterns for working with events in JavaScript.

Events communicate data across components. Events can contain attributes with values set before the event is fired and read when the event is handled.

Fire an Event

Fire a component event or an application event that's registered on a component.

```
//Fire a component event
var compEvent = cmp.getEvent("sampleComponentEvent");
compEvent.fire();

//Fire an application event
var appEvent = $A.get("e.c:appEvent");
appEvent.fire();
```

For more information, see:

- Fire Component Events
- Fire Application Events

Get an Event Name

To get the name of the event that's fired:

```
event.getSource().getName();
```

Get an Event Parameter

To get an attribute that's passed into an event:

```
event.getParam("value");
```

Get Parameters on an Event

To get all attributes that are passed into an event:

```
event.getParams();
```

`event.getParams()` returns an object containing all event parameters.

Get the Current Phase of an Event

To get the current phase of an event:

```
event.getPhase();
```

If the event hasn't been fired, `event.getPhase()` returns `undefined`. Possible return values for component and application events are `capture`, `bubble`, and `default`. Value events return `default`. For more information, see:

- Component Event Propagation
- Application Event Propagation

Get the Source Component

To get the component that fired the event:

```
event.getSource();
```

To retrieve an attribute on the component that fired the event:

```
event.getSource().get("v.myName");
```

Pause the Event

To pause the fired event:

```
event.pause();
```

If paused, the event is not handled until `event.resume()` is called. You can pause an event in the `capture` or `bubble` phase only. For more information, see:

- Handling Bubbled or Captured Component Events
- Handling Bubbled or Captured Application Events

Prevent the Default Event Execution

To cancel the default action on the event:

```
event.preventDefault();
```

For example, you can prevent a `lightning:button` component from submitting a form when it's clicked.

Resume a Paused Event

To resume event handling for a paused event:

```
event.resume();
```

You can resume a paused event in the `capture` or `bubble` phase only. For more information, see:

- Handling Bubbled or Captured Component Events
- Handling Bubbled or Captured Application Events

Set a Value for an Event Parameter

To set a value for an event parameter:

```
event.setParam("name", cmp.get("v.myName"));
```

If the event has already been fired, setting a parameter value has no effect on the event.

Set Values for Event Parameters

To set values for parameters on an event:

```
event.setParams({
    key : value
});
```

If the event has already been fired, setting the parameter values has no effect on the event.

Stop Event Propagation

To prevent further propagation of an event:

```
event.stopPropagation();
```

You can stop event propagation in the `capture` or `bubble` phase only.

Modifying the DOM

The Document Object Model (DOM) is the language-independent model for representing and interacting with objects in HTML and XML documents. It's important to know how to modify the DOM safely so that the framework's rendering service doesn't stomp on your changes and give you unexpected results.

IN THIS SECTION:

Modifying DOM Elements Managed by Aura

The framework creates and manages the DOM elements owned by a component. If you want to modify these DOM elements created by the framework, modify the DOM elements in the handler for the component's `render` event or in a custom renderer. Otherwise, the framework will override your changes when the component is rerendered.

For example, if you modify DOM elements directly from a client-side controller, the changes may be overwritten when the component is rendered.

You can read from the DOM outside a `render` event handler or a custom renderer.

The simplest approach is to leave DOM updates to the framework. Update a component's attribute and use an expression in the markup. The framework's rendering service takes care of the DOM updates.

You can modify CSS classes for a component outside a renderer by using the `$A.util.addClass()`, `$A.util.removeClass()`, and `$A.util.toggleClass()` methods.

There are some use cases where you want to perform post-processing on the DOM or react to rendering or rerendering of a component. For these use cases, there are a few options.

IN THIS SECTION:

Handle the render Event

When a component is rendered or rerendered, the `aura:valueRender` event, also known as the `render` event, is fired. Handle this event to perform post-processing on the DOM or react to component rendering or rerendering. The event is preferred and easier to use than the alternative of creating a custom renderer.

Create a Custom Renderer

The framework's rendering service takes in-memory component state and creates and manages the DOM elements owned by the component. If you want to modify DOM elements created by the framework for a component, you can modify the DOM elements in the component's renderer. Otherwise, the framework will override your changes when the component is rerendered.

SEE ALSO:

Modifying DOM Elements Managed by External Libraries

Using Expressions

Dynamically Showing or Hiding Markup

Handle the `render` Event

When a component is rendered or rerendered, the `aura:valueRender` event, also known as the `render` event, is fired. Handle this event to perform post-processing on the DOM or react to component rendering or rerendering. The event is preferred and easier to use than the alternative of creating a custom renderer.

The `render` event is fired after all methods in a custom renderer are invoked. For more details on the sequence in the rendering or rerendering lifecycles, see Create a Custom Renderer.

Handling the `aura:valueRender` event is similar to handling the `init` hook. Add a handler to your component's markup.

```
<aura:handler name="render" value="{!this}" action="{!c.onRender}"/>
```

In this example, the `onRender` action in your client-side controller handles initial rendering and rerendering of the component. You can choose any name for the `action` attribute.

SEE ALSO:

Invoking Actions on Component Initialization

Create a Custom Renderer

Create a Custom Renderer

The framework's rendering service takes in-memory component state and creates and manages the DOM elements owned by the component. If you want to modify DOM elements created by the framework for a component, you can modify the DOM elements in the component's renderer. Otherwise, the framework will override your changes when the component is rerendered.

The DOM is the language-independent model for representing and interacting with objects in HTML and XML documents. The framework automatically renders your components so you don't have to know anything more about rendering unless you need to customize the default rendering behavior for a component.

Note: It's preferred and easier to handle the `render` event rather than the alternative of creating a custom renderer.

Base Component Rendering

The base component in the framework is `aura:component`. Every component extends this base component.

The renderer for `aura:component` is in `componentRenderer.js`. This renderer has base implementations for the four phases of the rendering and rerendering cycles:

- `render()`
- `rerender()`
- `afterRender()`
- `unrender()`

The framework calls these functions as part of the rendering and rerendering lifecycles and we will learn more about them soon. You can override the base rendering functions in a custom renderer.

Rendering Lifecycle

The rendering lifecycle happens once in the lifetime of a component unless the component gets explicitly unrendered. When you create a component:

1. The framework fires an `init` event, enabling you to update a component or fire an event after component construction but before rendering.
2. The `render()` method is called to render the component's body.
3. The `afterRender()` method is called to enable you to interact with the DOM tree after the framework's rendering service has inserted DOM elements.
4. The framework fires a `render` event, enabling you to interact with the DOM tree after the framework's rendering service has inserted DOM elements. Handling the `render` event is preferred to creating a custom renderer and overriding `afterRender()`.

Rerendering Lifecycle

The rerendering lifecycle automatically handles rerendering of components whenever the underlying data changes. Here is a typical sequence.

1. A browser event triggers one or more Aura events.
2. Each Aura event triggers one or more actions that can update data. The updated data can fire more events.
3. The rendering service tracks the stack of events that are fired.
4. The framework rerenders all the components that own modified data by calling each component's `rerender()` method.
5. The framework fires a `render` event, enabling you to interact with the DOM tree after the framework rerenders a component. Handling the `render` event is preferred to creating a custom renderer and overriding `rerender()`.

The component rerendering lifecycle repeats whenever the underlying data changes as long as the component is valid and not explicitly unrendered.

For more information, see Events Fired During the Rendering Lifecycle .

Custom Renderer

You don't normally have to write a custom renderer, but it's useful when you want to interact with the DOM tree after the framework's rendering service has inserted DOM elements. If you want to customize rendering behavior and you can't do it in markup or by using the `init` event, you can create a client-side renderer.

A renderer file is part of the component bundle and is auto-wired if you follow the naming convention, `<componentName>Renderer.js`. For example, the renderer for `sample.cmp` would be in `sampleRenderer.js`.

To reuse a renderer from another component, you can use the `renderer` system attribute in `aura:component` instead. For example, this component uses the auto-wired renderer for `docsample.sampleComponent` in `docsample/sampleComponent/sampleComponentRenderer.js`.

```
<aura:component
    renderer="js://docsample.sampleComponent">
    ...
</aura:component>
```

Note: If you are reusing a renderer from another component and you already have an auto-wired renderer in your component bundle, the methods in your auto-wired renderer will not be accessible. We recommend that you use a renderer within the component bundle for maintainability and use an external renderer only if you must.

Note: These guidelines are important when you customize rendering.

- Only modify DOM elements that are part of the component. Never break component encapsulation by reaching in to another component and changing its DOM elements, even if you are reaching in from the parent component.
- Never fire an event as it can trigger new rendering cycles. An alternative is to use an `init` event instead.
- Don't set attribute values on other components as these changes can trigger new rendering cycles.
- Move as much of the UI concerns, including positioning, to CSS.

Customize Component Rendering

Customize rendering by creating a `render()` function in your component's renderer to override the base `render()` function, which updates the DOM.

The `render()` function returns a DOM node, an array of DOM nodes, or nothing. The base HTML component expects DOM nodes when it renders a component.

You generally want to extend default rendering by calling `superRender()` from your `render()` function before you add your custom rendering code. Calling `superRender()` creates the DOM nodes specified in the markup.

This code outlines a custom `render()` function.

```
render : function(cmp, helper) {
    var ret = this.superRender();
    // do custom rendering here
    return ret;
},
```

Rerender Components

When an event is fired, it may trigger actions to change data and call `rerender()` on affected components. The `rerender()` function enables components to update themselves based on updates to other components since they were last rendered. This function doesn't return a value.

If you update data in a component, the framework automatically calls `rerender()`.

You generally want to extend default rerendering by calling `superRerender()` from your `renderer()` function before you add your custom rerendering code. Calling `superRerender()` chains the rerendering to the components in the `body` attribute.

This code outlines a custom `rerender()` function.

```
rerender : function(cmp, helper){
    this.superRerender();
    // do custom rerendering here
}
```

Access the DOM After Rendering

The `afterRender()` function enables you to interact with the DOM tree after the framework's rendering service has inserted DOM elements. It's not necessarily the final call in the rendering lifecycle; it's simply called after `render()` and it doesn't return a value.

You generally want to extend default after rendering by calling `superAfterRender()` function before you add your custom code.

This code outlines a custom `afterRender()` function.

```
afterRender: function (component, helper) {
    this.superAfterRender();
    // interact with the DOM here
},
```

Unrender Components

The base `unrender()` function deletes all the DOM nodes rendered by a component's `render()` function. It is called by the framework when a component is being destroyed. Customize this behavior by overriding `unrender()` in your component's renderer. This method can be useful when you are working with third-party libraries that are not native to the framework.

You generally want to extend default unrendering by calling `superUnrender()` from your `unrender()` function before you add your custom code.

This code outlines a custom `unrender()` function.

```
unrender: function () {
    this.superUnrender();
    // do custom unrendering here
}
```

Ensure Client-Side Rendering

The framework calls the default server-side renderer by default, or a client-side renderer if you have one. To ensure client-side rendering of a top-level component, append `render="client"` to the `aura:component` tag. Setting `render="client"` in the top-level component takes precedence over the framework's detection logic, which takes dependencies into consideration. This behavior is useful if you're testing the component in your browser and want to inspect the component using the client-side framework when the test loads. Setting `render="client"` for test components ensures that the client-side framework is loaded, even though it normally would"t be needed.

SEE ALSO:

- Modifying the DOM
- Invoking Actions on Component Initialization
- Component Bundles
- Modifying Components Outside the Framework Lifecycle
- Sharing JavaScript Code in a Component Bundle
- Server-Side Rendering to the DOM

Modifying DOM Elements Managed by External Libraries

You can use different libraries, such as a charting library, to create and manage DOM elements. You don't have to modify these DOM elements within the `render` event handler or a renderer because they are managed by the external library.

A `render` event handler or a renderer are used only to customize DOM elements created and managed by Aura.

SEE ALSO:

- Modifying DOM Elements Managed by Aura

Client-Side Runtime Binding of Components

A provider enables you to use an abstract component in markup. The framework uses the provider to determine the concrete component to use at runtime.

Server-side providers are more common, but if you don't need to access the server when you're creating a component, you can use a client-side provider instead.

Note: The framework behavior is undefined if a component has a client-side provider and a server-side provider that return different values. It's preferable to only use a server-side or a client-side provider unless you need both.

Creating a Provider

A client-side provider is part of the component bundle and is auto-wired if you follow the naming convention, `<componentName>Provider.js.`

To reuse a provider from another component, you can use the `provider` system attribute in `aura:component` instead. For example, this component uses the auto-wired provider for `auradocs.sampleComponent` in `auradocs/sampleComponent/sampleComponentProvider.js`.

```
<aura:component
    provider="js://auradocs.sampleComponent">
    ...
</aura:component>
```

Note: If you are reusing a provider from another component and you already have an auto-wired provider in your component bundle, the methods in your auto-wired provider will not be accessible. We recommend that you use a provider within the component bundle for maintainability and use an external provider only if you must.

A client-side provider is a simple JavaScript object that defines the `provide` function. For example, this provider returns a string that defines the topic to display.

```
({
    provide : function (cmp) {
        var topic = cmp.get('v.topic');
        return 'auradocs' + topic + 'Topic';
    }
})
```

Instead of a string, a provider can return a JSON object to provide both the concrete component and set some additional attributes. For example:

```
({
    provide : function (cmp) {
        var topic = cmp.get('v.topic');
        return {
            componentDef: 'auradocs' + topic + 'Topic',
            attributes: {
                "type": "task"
            }
        }
    }
})
```

You can omit the `componentDef` entry if the component is already concrete and you only want to provide attributes.

Declaring Provider Dependencies

The framework automatically tracks dependencies between definitions, such as components. However, if a component uses a provider that instantiates components that are not directly referenced elsewhere, use `<aura:dependency>` in the component markup to explicitly tell the framework about the dependency, which wouldn't otherwise be discovered.

SEE ALSO:

Server-Side Runtime Binding of Components

Abstract Components

Interfaces

Component Bundles

aura:dependency

Checking Component Validity

If you navigate elsewhere in the UI while asynchronous code is executing, the framework unrenders and destroys the component that made the asynchronous request. You can still have a reference to that component, but it is no longer valid. The `cmp.isValid()` call returns `false` for an invalid component.

If you call `cmp.get()` on an invalid component, `cmp.get()` returns `null`.

If you call `cmp.set()` on an invalid component, nothing happens and no error occurs. It's essentially a no op.

In many scenarios, the `cmp.isValid()` call isn't necessary because a `null` check on a value retrieved from `cmp.get()` is sufficient. The main reason to call `cmp.isValid()` is if you're making multiple calls against the component and you want to avoid a `null` check for each result.

Inside the Framework Lifecycle

You don't need a `cmp.isValid()` check in the callback in a client-side controller when you reference the component associated with the client-side controller. The framework automatically checks that the component is valid. Similarly, you don't need a `cmp.isValid()` check during event handling or in a framework lifecycle hook, such as the `init` event.

Let's look at a sample client-side controller.

```
({
    "doSomething" : function(cmp) {
        var action = cmp.get("c.serverEcho");
        action.setCallback(this, function(response) {
            var state = response.getState();
            if (state === "SUCCESS") {
                if (cmp.get("v.displayResult)) {
                    alert("From server: " + response.getReturnValue());
                }
            }
            // other state handling omitted for brevity
        });

        $A.enqueueAction(action);
    }
})
```

The component wired to the client-side controller is passed into the `doSomething` action as the `cmp` parameter. When `cmp.get("v.displayResult)` is called, we don't need a `cmp.isValid()` check.

However, if you hold a reference to another component that may not be valid despite your component being valid, you might need a `cmp.isValid()` check for the other component. Let's look at another example of a component that has a reference to another component with a local ID of `child`.

```
({
    "doSomething" : function(cmp) {
        var action = cmp.get("c.serverEcho");
        var child = cmp.find("child");
        action.setCallback(this, function(response) {
            var state = response.getState();
            if (state === "SUCCESS") {
                if (child.get("v.displayResult)) {
                    alert("From server: " + response.getReturnValue());
                }
            }
            // other state handling omitted for brevity
        });

        $A.enqueueAction(action);
    }
})
```

This line in the previous example without the child component:

```
if (cmp.get("v.displayResult)) {
```

changed to:

```
if (child.get("v.displayResult)) {
```

You don't need a `child.isValid()` call here as `child.get("v.displayResult)` will return `null` if the child component is invalid. Add a `child.isValid()` check only if you're making multiple calls against the child component and you want to avoid a `null` check for each result.

Outside the Framework Lifecycle

If you reference a component in asynchronous code, such as `setTimeout()` or `setInterval()`, or when you use Promises, a `cmp.isValid()` call checks that the component is still valid before processing the results of the asynchronous request. In many scenarios, the `cmp.isValid()` call isn't necessary because a `null` check on a value retrieved from `cmp.get()` is sufficient. The main reason to call `cmp.isValid()` is if you're making multiple calls against the component and you want to avoid a `null` check for each result.

For example, you don't need a `cmp.isValid()` check within this `setTimeout()` call as the `cmp.set()` call doesn't do anything when the component is invalid.

```
window.setTimeout(
    $A.getCallback(function() {
        cmp.set("v.visible", true);
    }), 5000
);
```

SEE ALSO:

Handling Events with Client-Side Controllers

Invoking Actions on Component Initialization

Modifying Components Outside the Framework Lifecycle

Modifying Components Outside the Framework Lifecycle

Use `$A.getCallback()` to wrap any code that modifies a component outside the normal rerendering lifecycle, such as in a `setTimeout()` call. The `$A.getCallback()` call ensures that the framework rerenders the modified component and processes any enqueued actions.

Note: `$A.run()` is deprecated. Use `$A.getCallback()` instead.

You don't need to use `$A.getCallback()` if your code is executed as part of the framework's call stack; for example, your code is handling an event or in the callback for a server-side controller action.

An example of where you need to use `$A.getCallback()` is calling `window.setTimeout()` in an event handler to execute some logic after a time delay. This puts your code outside the framework's call stack.

This sample sets the `visible` attribute on a component to `true` after a five-second delay.

```
window.setTimeout(
    $A.getCallback(function() {
```

```
        cmp.set("v.visible", true);
    }), 5000
);
```

Note how the code updating a component attribute is wrapped in `$A.getCallback()`, which ensures that the framework rerenders the modified component.

Note: You don't need a `cmp.isValid()` check within this `setTimeout()` call as the `cmp.set()` call doesn't do anything when the component is invalid.

Warning: Don't save a reference to a function wrapped in `$A.getCallback()`. If you use the reference later to send actions, the saved transaction state will cause the actions to be aborted.

SEE ALSO:

Handling Events with Client-Side Controllers

Checking Component Validity

Firing Aura Events from Non-Aura Code

Communicating with Events

Validating Fields

Validate user input, handle errors, and display error messages on input fields.

Client-side input validation is available for the following components:

- `lightning:input`
- `lightning:select`
- `lightning:textarea`
- `ui:input*`

Components in the `lightning` namespace simplify input validation by providing attributes to define error conditions, enabling you to handle errors by checking the component's validity state. For example, you can set a minimum length for a field , display an error message when the condition is not met, and handle the error based on the given validity state.

Alternatively, input components in the `ui` namespace let you define and handle errors in a client-side controller, enabling you to iterate through a list of errors.

The following sections discuss error handling for `ui:input*` components.

Default Error Handling

The framework can handle and display errors using the default error component, `ui:inputDefaultError`. This component is dynamically created when you set the errors using the `inputCmp.set("v.errors",[{message:"my error message"}])` syntax. The following example shows how you can handle a validation error and display an error message. Here is the markup.

```
<!--c:errorHandling-->
<aura:component>
    Enter a number: <ui:inputNumber aura:id="inputCmp"/> <br/>
    <lightning:button label="Submit" onclick="{!c.doAction}"/>
</aura:component>
```

Here is the client-side controller.

```
/*errorHandlingController.js*/
{
    doAction : function(component) {
        var inputCmp = component.find("inputCmp");
        var value = inputCmp.get("v.value");

        // Is input numeric?
        if (isNaN(value)) {
            // Set error
            inputCmp.set("v.errors", [{message:"Input not a number: " + value}]);
        } else {
            // Clear error
            inputCmp.set("v.errors", null);
        }
    }
}
```

When you enter a value and click **Submit**, `doAction` in the controller validates the input and displays an error message if the input is not a number. Entering a valid input clears the error. Add error messages to the input component using the `errors` attribute.

Custom Error Handling

`ui:input` and its child components can handle errors using the `onError` and `onClearErrors` events, which are wired to your custom error handlers defined in a controller. `onError` maps to a `ui:validationError` event, and `onClearErrors` maps to `ui:clearErrors`.

The following example shows how you can handle a validation error using custom error handlers and display the error message using the default error component. Here is the markup.

```
<!--c:errorHandlingCustom-->
<aura:component>
    Enter a number: <ui:inputNumber aura:id="inputCmp" onError="{!c.handleError}"
onClearErrors="{!c.handleClearError}"/> <br/>
    <ui:button label="Submit" press="{!c.doAction}"/>
</aura:component>
```

Here is the client-side controller.

```
/*errorHandlingCustomController.js*/
{
    doAction : function(component, event) {
        var inputCmp = component.find("inputCmp");
        var value = inputCmp.get("v.value");

        // is input numeric?
        if (isNaN(value)) {
            inputCmp.set("v.errors", [{message:"Input not a number: " + value}]);
        } else {
            inputCmp.set("v.errors", null);
        }
    },

    handleError: function(component, event){
```

```
        /* do any custom error handling
         * logic desired here */
        // get v.errors, which is an Object[]
        var errorsArr  = event.getParam("errors");
        for (var i = 0; i < errorsArr.length; i++) {
            console.log("error " + i + ": " + JSON.stringify(errorsArr[i]));
        }
    },

    handleClearError: function(component, event) {
        /* do any custom error handling
         * logic desired here */
    }
}
```

When you enter a value and click **Submit**, `doAction` in the controller executes. However, instead of letting the framework handle the errors, we define a custom error handler using the `onError` event in `<ui:inputNumber>`. If the validation fails, `doAction` adds an error message using the `errors attribute`. This automatically fires the `handleError` custom error handler.

Similarly, you can customize clearing the errors by using the `onClearErrors` event. See the `handleClearError` handler in the controller for an example.

SEE ALSO:

Handling Events with Client-Side Controllers

Component Events

Throwing and Handling Errors

The framework gives you flexibility in handling unrecoverable and recoverable app errors in JavaScript code. For example, you can throw these errors in a callback when handling an error in a server-side response.

Unrecoverable Errors

Use `throw new Error("error message here")` for unrecoverable errors, such as an error that prevents your app from starting successfully. The error message and a stack trace are displayed.

Note: `$A.error()` is deprecated. Throw the native JavaScript `Error` object instead by using `throw new Error()`.

This example shows you the basics of throwing an unrecoverable error in a JavaScript controller.

```
<!--c:unrecoverableError-->
<aura:component>
    <lightning:button label="throw error" onclick="{!c.throwError}"/>
</aura:component>
```

Here is the client-side controller source.

```
/*unrecoverableErrorController.js*/
({
    throwError : function(component, event){
        throw new Error("I can't go on. This is the end.");
```

```
    }
})
```

Recoverable Errors

Throw an instance of `$A.auraFriendlyError()` for recoverable errors.

This example shows you the basics of throwing and handling an error in a JavaScript controller.

```
<!--c:recoverableError-->
<aura:component>
    <aura:handler event="aura:systemError" action="{!c.showError}"/>

    <ui:button label="throw error" press="{!c.throwError}"/>
    <div aura:id="myError" class="isDisplayed message" >
        <ui:outputText aura:id="message" value=""/>
        <lightning:button label="OK" onclick="{!c.hideError}"/>
    </div>
</aura:component>
```

Click **throw error** to call `throwError` in the client-side controller.

In this simple example, we display an error message using a `ui:outputText` component. Typically, you use a component, such as `ui:message` or `ui:panel`, to tell the user about the problem. Another button labeled **OK** lets you dismiss the error.

Here is the client-side controller source.

```
/*recoverableErrorController.js*/
({
    throwError : function(cmp, event){
        // error is an instance of AuraFriendlyError
        // argument sets the message property of AuraFriendlyError
        var error = new $A.auraFriendlyError("This is a sample error.");
        // set an optional error data object
        error.data = {
            "moreErrorData1": "more1",
            "moreErrorData2": "more2",
        };
        throw error;
    },

    showError: function(cmp, event) {
        // handle the error by displaying a message
        var myErrorCmp = cmp.find('myError');
        var messageCmp = cmp.find('message');

        // get the error object from aura:systemError event
        // This is the AuraFriendlyError object
        var afe = event.getParam('auraError');
        if (afe) {
            // message is the argument set in AuraFriendlyError
            var message = afe.message;
            $A.util.removeClass(myErrorCmp, "isDisplayed");
            messageCmp.set("v.value", message
                + JSON.stringify(afe.data));
```

```
        }
        // aura:systemError event has been handled
        event["handled"] = true;
    },

     hideError : function(cmp){
        // hide the error message from view
        var myErrorCmp = cmp.find('myError');
        $A.util.addClass(myErrorCmp,"isDisplayed");
    }

})
```

The `throwError` method throws an instance of `$A.auraFriendlyError()`, which triggers firing of the `aura:systemError` event.

Set the error message in the `message` property of `AuraFriendlyError`, which corresponds to the first argument of `$A.auraFriendlyError()`. Set an optional object with more context in the `data` property of `AuraFriendlyError`.

An `aura:systemError` event handler in the markup calls `showError` to handle the error.

Set `event["handled"]=true` in `showError` to indicate that you're providing your own error handler for the `aura:systemError` event.

Here is the CSS.

```
/*recoverableError.css*/
.THIS.isDisplayed {
    display: none;
}
```

SEE ALSO:

Validating Fields

Calling Component Methods

Use `<aura:method>` to define a method as part of a component's API. This enables you to directly call a method in a component's client-side controller instead of firing and handling a component event. Using `<aura:method>` simplifies the code needed for a parent component to call a method on a child component that it contains.

Communicate Between Components

Use `aura:method` to communicate down the containment hierarchy. For example, a parent component calls an `aura:method` on a child component that it contains.

To communicate up the containment hierarchy, fire a component event in the child component and handle it in the parent component.

Syntax

Use this syntax to call a method in JavaScript code.

```
cmp.sampleMethod(arg1, … argN);
```

`cmp` is a reference to the component.

`sampleMethod` is the name of the `aura:method`.

`arg1, … argN` is an optional comma-separated list of arguments passed to the method. Each argument corresponds to an `aura:attribute` defined in the `aura:method` markup.

Using Inherited Methods

A sub component that extends a super component has access to any methods defined in the super component.

An interface can also include an `<aura:method>` tag. A component that implements the interface can access the method.

Example

Let's look at an example app.

```
<!-- c:auraMethodCallerWrapper.app -->
<aura:application >
    <c:auraMethodCaller />
</aura:application>
```

`c:auraMethodCallerWrapper.app` contains a `c:auraMethodCaller` component.

```
<!-- c:auraMethodCaller.cmp -->
<aura:component >
    <p>Parent component calls aura:method in child component</p>
    <c:auraMethod aura:id="child" />

    ...
</aura:component>
```

`c:auraMethodCaller` is the parent component. `c:auraMethodCaller` contains the child component, `c:auraMethod`.

We'll show how `c:auraMethodCaller` calls an `aura:method` defined in `c:auraMethod`.

We'll use `c:auraMethodCallerWrapper.app` to see how to return results from synchronous and asynchronous code.

IN THIS SECTION:

SEE ALSO:

aura:method

Component Events

Return Result for Synchronous Code

`aura:method` executes synchronously. A synchronous method finishes executing before it returns. Use the `return` statement to return a value from synchronous JavaScript code.

An asynchronous method can continue to execute after it returns. JavaScript code often uses the callback pattern to return a result after asynchronous code completes. We'll describe later how to return a result for an asynchronous action.

Step 1: Define `aura:method` in Markup

Let's look at a `logParam` `aura:method` that executes synchronous code. We'll use the `c:auraMethodCallerWrapper.app` and components outlined in Calling Component Methods. Here's the markup that defines the `aura:method`.

```
<!-- c:auraMethod -->
<aura:component>
    <aura:method name="logParam"
      description="Sample method with parameter">
        <aura:attribute name="message" type="String" default="default message" />
    </aura:method>

    <p>This component has an aura:method definition.</p>
</aura:component>
```

The `logParam` `aura:method` has an `aura:attribute` with a name of `message`. This attribute enables you to set a `message` parameter when you call the `logParam` method.

The name attribute of `logParam` configures the `aura:method` to invoke `logParam()` in the client-side controller.

An `aura:method` can have multiple `aura:attribute` tags. Each `aura:attribute` corresponds to a parameter that you can pass into the `aura:method`. For more details on the syntax, see aura:method.

You don't explicitly declare a return value in the `aura:method` markup. You just use a `return` statement in the JavaScript controller.

Step 2: Implement `aura:method` Logic in Controller

The `logParam` `aura:method` invokes `logParam()` in `auraMethodController.js`. Let's look at that source.

```
/* auraMethodController.js */
({
    logParam : function(cmp, event) {
        var params = event.getParam('arguments');
        if (params) {
            var message = params.message;
            console.log("message: " + message);
            return message;
        }
    },
})
```

`logParam()` simply logs the parameter passed in and returns the parameter value to demonstrate how to use the `return` statement. If your code is synchronous, you can use a `return` statement; for example, you're not making an asynchronous server-side action call.

Step 3: Call `aura:method` from Parent Controller

`callAuraMethod()` in the controller for `c:auraMethodCaller` calls the `logParam` `aura:method` defined in its child component, `c:auraMethod`. Here's the controller for `c:auraMethodCaller`.

```
/* auraMethodCallerController.js */
({
    callAuraMethod : function(component, event, helper) {
        var childCmp = component.find("child");
        // call the aura:method in the child component
        var auraMethodResult =
          childCmp.logParam("message sent by parent component");
        console.log("auraMethodResult: " + auraMethodResult);
    },
})
```

`callAuraMethod()` finds the child component, `c:auraMethod`, and calls its `logParam` `aura:method` with an argument for the message parameter of the `aura:method`.

```
childCmp.logParam("message sent by parent component");
```

`auraMethodResult` is the value returned from `logParam`.

Step 4: Add Button to Initiate Call to `aura:method`

The `c:auraMethodCaller` markup contains a `lightning:button` that invokes `callAuraMethod()` in `auraMethodCallerController.js`. We use this button to initiate the call to `aura:method` in the child component.

```
<!-- c:auraMethodCaller.cmp -->
<aura:component >
    <p>Parent component calls aura:method in child component</p>
    <c:auraMethod aura:id="child" />

    <lightning:button label="Call aura:method in child component"
        onclick="{! c.callAuraMethod}" />
</aura:component>
```

SEE ALSO:

Return Result for Asynchronous Code

Calling Component Methods

aura:method

Return Result for Asynchronous Code

`aura:method` executes synchronously. Use the `return` statement to return a value from synchronous JavaScript code. JavaScript code that calls a server-side action is asynchronous. Asynchronous code can continue to execute after it returns. You can't use the `return` statement to return the result of an asynchronous call because the `aura:method` returns before the asynchronous code completes. For asynchronous code, use a callback instead of a `return` statement.

Step 1: Define **aura:method** in Markup

Let's look at an `echo aura:method` that uses a callback. We'll use the `c:auraMethodCallerWrapper.app` and components outlined in Calling Component Methods. Here's the `echo aura:method` in the `c:auraMethod` component.

```
<!-- c:auraMethod -->
<aura:component controller="SimpleServerSideController">
    <aura:method name="echo"
      description="Sample method with server-side call">
        <aura:attribute name="callback" type="Function" />
    </aura:method>

    <p>This component has an aura:method definition.</p>
</aura:component>
```

The `echo aura:method` has an `aura:attribute` with a name of callback. This attribute enables you to set a callback that's invoked by the `aura:method` after execution of the server-side action in `SimpleServerSideController`.

Step 2: Implement **aura:method** Logic in Controller

The `echo aura:method` invokes `echo()` in `auraMethodController.js`. Let's look at the source.

```
/* auraMethodController.js */
({
    echo : function(cmp, event) {
        var params = event.getParam('arguments');
        var callback;
        if (params) {
            callback = params.callback;
        }

        var action = cmp.get("c.serverEcho");
        action.setCallback(this, function(response) {
            var state = response.getState();
            if (state === "SUCCESS") {
                console.log("From server: " + response.getReturnValue());
                // return doesn't work for async server action call
                //return response.getReturnValue();
                // call the callback passed into aura:method
                if (callback) callback(response.getReturnValue());
            }
            else if (state === "INCOMPLETE") {
                // do something
            }
            else if (state === "ERROR") {
                var errors = response.getError();
                if (errors) {
                    if (errors[0] && errors[0].message) {
                        console.log("Error message: " +
                          errors[0].message);
                    }
                } else {
                    console.log("Unknown error");
                }
```

```
            }
        });
        $A.enqueueAction(action);
    },
})
```

echo() calls the serverEcho() server-side controller action, which we'll create next.

Note: You can't return the result with a return statement. The aura:method returns before the asynchronous server-side action call completes. Instead, we invoke the callback passed into the aura:method and set the result as a parameter in the callback.

Step 3: Create Apex Server-Side Controller

The echo aura:method calls a server-side controller action called serverEcho. Here's the source for the server-side controller.

```
public with sharing class SimpleServerSideController {
    @AuraEnabled
    public static String serverEcho() {
        return ('Hello from the server');
    }
}
```

The serverEcho() method returns a String.

Step 4: Call aura:method from Parent Controller

Here's the controller for c:auraMethodCaller. It calls the echo aura:method in its child component, c:auraMethod.

```
/* auraMethodCallerController.js */
({
    callAuraMethodServerTrip : function(component, event, helper) {
        var childCmp = component.find("child");
        // call the aura:method in the child component
        childCmp.echo(function(result) {
            console.log("callback for aura:method was executed");
            console.log("result: " + result);
        });
    },
})
```

callAuraMethodServerTrip() finds the child component, c:auraMethod, and calls its echo aura:method. echo() passes a callback function into the aura:method.

The callback configured in auraMethodCallerController.js logs the result.

```
function(result) {
    console.log("callback for aura:method was executed");
    console.log("result: " + result);
}
```

Step 5: Add Button to Initiate Call to **aura:method**

The c:auraMethodCaller markup contains a lightning:button that invokes callAuraMethodServerTrip() in auraMethodCallerController.js. We use this button to initiate the call to the aura:method in the child component.

Here's the markup for c:auraMethodCaller.

```
<!-- c:auraMethodCaller.cmp -->
<aura:component >
    <p>Parent component calls aura:method in child component</p>
    <c:auraMethod aura:id="child" />

    <lightning:button label="Call aura:method (server trip) in child component"
        onclick="{! c.callAuraMethodServerTrip}" />
</aura:component>
```

SEE ALSO:

Return Result for Synchronous Code

Calling Component Methods

aura:method

Dynamically Adding Event Handlers To a Component

You can dynamically add a handler for an event that a component fires.

The addEventHandler() method in the Component object replaces the deprecated addHandler() method.

To add an event handler to a component dynamically, use the addEventHandler() method.

```
addEventHandler(String event, Function handler, String phase, String includeFacets)
```

event

The first argument is the name of the event that triggers the handler. You can't force a component to start firing events that it doesn't fire, so make sure that this argument corresponds to an event that the component fires. The <aura:registerEvent> tag in a component's markup advertises an event that the component fires.

- For a component event, set this argument to match the name attribute of the <aura:registerEvent> tag.
- For an application event, set this argument to match the event descriptor in the format namespace:eventName.

handler

The second argument is the action that handles the event. The format is similar to the value you would put in the action attribute in the <aura:handler> tag if the handler was statically defined in the markup. There are two options for this argument.

- To use a controller action, use the format: cmp.getReference("c.actionName").
- To use an anonymous function, use the format:

```
function(auraEvent) {
    // handling logic here
}
```

For a description of the other arguments, see the JavaScript API in the doc reference app.

You can also add an event handler to a component that is created dynamically in the callback function of $A.createComponent(). For more information, see Dynamically Creating Components.

Example

This component has buttons to fire and handle a component event and an application event.

```
<!--c:dynamicHandler-->
<aura:component >
    <aura:registerEvent name="compEvent" type="c:sampleEvent"/>
    <aura:registerEvent name="appEvent" type="c:appEvent"/>
    <h1>Add dynamic handler for event</h1>
    <p>
        <lightning:button label="Fire component event" onclick="{!c.fireEvent}" />
        <lightning:button label="Add dynamic event handler for component event"
onclick="{!c.addEventHandler}" />
    </p>
    <p>
        <lightning:button label="Fire application event" onclick="{!c.fireAppEvent}" />
        <lightning:button label="Add dynamic event handler for application event"
onclick="{!c.addAppEventHandler}" />
    </p>

</aura:component>
```

Here's the client-side controller.

```
/* dynamicHandlerController.js */
({
    fireEvent : function(cmp, event) {
        // Get the component event by using the
        // name value from <aura:registerEvent> tag
        var compEvent = cmp.getEvent("compEvent");
        compEvent.fire();
        console.log("Fired a component event");
    },

    addEventHandler : function(cmp, event) {
        // First param matches name attribute in <aura:registerEvent> tag
        cmp.addEventHandler("compEvent", cmp.getReference("c.handleEvent"));
        console.log("Added handler for component event");
    },

    handleEvent : function(cmp, event) {
        alert("Handled the component event");
    },

    fireAppEvent : function(cmp, event) {
        var appEvent = $A.get("e.c:appEvent");
        appEvent.fire();
        console.log("Fired an application event");
    },

    addAppEventHandler : function(cmp, event) {
        // Can use cmp.getReference() or anonymous function for handler
        // First param is event descriptor, "c:appEvent", for application events
        cmp.addEventHandler("c:appEvent", cmp.getReference("c.handleAppEvent"));
        // Can alternatively use anonymous function for handler
```

```
        //cmp.addEventHandler("c:appEvent", function(auraEvent) {
            // console.log("Handled the application event in anonymous function");
        //});
        console.log("Added handler for application event");
    },

    handleAppEvent : function(cmp, event) {
        alert("Handled the application event");
    }
})
```

Notice the first parameter of the `addEventHandler()` calls. The syntax for a component event is:

```
cmp.addEventHandler("compEvent", cmp.getReference("c.handleEvent"));
```

The syntax for an application event is:

```
cmp.addEventHandler("c:appEvent", cmp.getReference("c.handleAppEvent"));
```

For either a component or application event, you can use an anonymous function as a handler instead of using `cmp.getReference()` for a controller action.

For example, the application event handler could be:

```
cmp.addEventHandler("c:appEvent", function(auraEvent) {
    // add handler logic here
    console.log("Handled the application event in anonymous function");
});
```

SEE ALSO:

Handling Events with Client-Side Controllers

Handling Component Events

Reference Doc App

Creating a Document-Level Event Handler

To create a document-level event handler, call `addDocumentLevelHandler(String eventName, Function callback, Boolean autoEnable)`. This creates and returns a handler object that can be enabled and disabled with `setEnabled(Boolean)`.

Note: Document-level event handlers are global objects so using many of them could have performance implications.

An example of when a document-level event handler can be useful is with modal dialogs that should close when someone clicks outside of them. Here is an example of how to add a document-level event handler. This code is from the `datePickerHelper.js` code that is part of the `datePicker` component:

```
updateGlobalEventListeners: function(component) {
    var concreteCmp = component.getConcreteComponent();
    var visible = concreteCmp.get("v.visible");
    if (!concreteCmp._clickStart) {
        concreteCmp._clickStart = concreteCmp.addDocumentLevelHandler(
          this.getOnClickEventProp("onClickStartEvent"),
          this.getOnClickStartFunction(component),
```

```
          visible);
        concreteCmp._clickEnd = concreteCmp.addDocumentLevelHandler(
          this.getOnClickEventProp("onClickEndEvent"),
          this.getOnClickEndFunction(component),
          visible);
    } else {
        concreteCmp._clickStart.setEnabled(visible);
        concreteCmp._clickEnd.setEnabled(visible);
  }
},
```

The document-level event handlers will be cleaned up automatically when the component is destroyed. If you need to destroy the document-level event handler earlier, call `removeDocumentLevelHandler()`.

Dynamically Showing or Hiding Markup

You can use CSS to toggle markup visibility. However, `<aura:if>` is the preferred approach because it defers the creation and rendering of the enclosed element tree until needed.

For an example using `<aura:if>`, see Best Practices for Conditional Markup.

This example uses `$A.util.toggleClass(cmp, 'class')` to toggle visibility of markup.

```
<!--c:toggleCss-->
<aura:component>
    <lightning:button label="Toggle" onclick="{!c.toggle}"/>
    <p aura:id="text">Now you see me</p>
</aura:component>
```

```
/*toggleCssController.js*/
({
    toggle : function(component, event, helper) {
        var toggleText = component.find("text");
        $A.util.toggleClass(toggleText, "toggle");
    }
})
```

```
/*toggleCss.css*/
.THIS .toggle {
    display: none;
}
```

Click the **Toggle** button to hide or show the text by toggling the CSS class.

SEE ALSO:

- Handling Events with Client-Side Controllers
- Component Attributes
- Adding and Removing Styles

Adding and Removing Styles

You can add or remove a CSS style on a component or element during runtime.

To retrieve the class name on a component, use `component.find('myCmp').get('v.class')`, where `myCmp` is the `aura:id` attribute value.

To append and remove CSS classes from a component or element, use the `$A.util.addClass(cmpTarget, 'class')` and `$A.util.removeClass(cmpTarget, 'class')` methods.

Component source

```
<aura:component>
    <div aura:id="changeIt">Change Me!</div><br />
    <lightning:button onclick="{!c.applyCSS}" label="Add Style" />
    <lightning:button onclick="{!c.removeCSS}" label="Remove Style" />
</aura:component>
```

CSS source

```
.THIS.changeMe {
    background-color:yellow;
    width:200px;
}
```

Client-side controller source

```
{
    applyCSS: function(cmp, event) {
        var cmpTarget = cmp.find('changeIt');
        $A.util.addClass(cmpTarget, 'changeMe');
    },

    removeCSS: function(cmp, event) {
        var cmpTarget = cmp.find('changeIt');
        $A.util.removeClass(cmpTarget, 'changeMe');
    }
}
```

The buttons in this demo are wired to controller actions that append or remove the CSS styles. To append a CSS style to a component, use `$A.util.addClass(cmpTarget, 'class')`. Similarly, remove the class by using `$A.util.removeClass(cmpTarget, 'class')` in your controller. `cmp.find()` locates the component using the local ID, denoted by `aura:id="changeIt"` in this demo.

Toggling a Class

To toggle a class, use `$A.util.toggleClass(cmp, 'class')`, which adds or removes the class.

The `cmp` parameter can be component or a DOM element.

Note: We recommend using a component instead of a DOM element. If the utility function is not used inside `afterRender()` or `rerender()`, passing in `cmp.getElement()` might result in your class not being applied when the components are rerendered. For more information, see Events Fired During the Rendering Lifecycle on page 139.

To hide or show markup dynamically, see Dynamically Showing or Hiding Markup on page 203.

To conditionally set a class for an array of components, pass in the array to `$A.util.toggleClass()`.

```
mapClasses: function(arr, cssClass) {
    for(var cmp in arr) {
        $A.util.toggleClass(arr[cmp], cssClass);
    }
}
```

SEE ALSO:

Handling Events with Client-Side Controllers

CSS in Components

Component Bundles

Which Button Was Pressed?

To find out which button was pressed in a component containing multiple buttons, use `Component.getLocalId()`.

The framework provides two button components—`ui:button` and `lightning:button`.

Note: We recommend that you use `lightning:button`, a button component that comes with Lightning Design System styling.

Let's look at an example with multiple `ui:button` components. Each button has a unique local ID, set by an `aura:id` attribute.

```
<!--c:buttonPressed-->
<aura:component>
    <aura:attribute name="whichButton" type="String" />

    <p>You clicked: {!v.whichButton}</p>

    <ui:button aura:id="button1" label="Click me" press="{!c.nameThatButton}"/>
    <ui:button aura:id="button2" label="Click me too" press="{!c.nameThatButton}"/>
</aura:component>
```

Use `event.getSource()` in the client-side controller to get the button component that was clicked. Call `getLocalId()` to get the `aura:id` of the clicked button.

```
/* buttonPressedController.js */
({
    nameThatButton : function(cmp, event, helper) {
        var whichOne = event.getSource().getLocalId();
        console.log(whichOne);
        cmp.set("v.whichButton", whichOne);
    }
})
```

If you're using `lightning:button`, use the `onclick` event handler instead of the `press` event handler.

```
<aura:component>
    <aura:attribute name="whichButton" type="String" />

    <p>You clicked: {!v.whichButton}</p>

    <lightning:button aura:id="button1" name="buttonname1" label="Click me"
```

```
onclick="{!c.nameThatButton}"/>
    <lightning:button aura:id="button2" name="buttonname2" label="Click me"
onclick="{!c.nameThatButton}"/>
</aura:component>
```

In the client-side controller, you can use one of the following methods to find out which button was clicked.

- `event.getSource().getLocalId()` returns the `aura:id` of the clicked button.
- `event.getSource().get("v.name")` returns the `name` of the clicked button.

SEE ALSO:

Component IDs

Finding Components by ID

Formatting Dates in JavaScript

The `AuraLocalizationService` JavaScript API provides methods for formatting and localizing dates.

For example, the `formatDate()` method formats a date based on the `formatString` parameter set as the second argument.

```
formatDate (String | Number | Date date, String formatString)
```

The `date` parameter can be a String, Number, or most typically a JavaScript Date. If you provide a String value, use ISO 8601 format to avoid parsing warnings.

The `formatString` parameter contains tokens to format a date and time. For example, `"YYYY-MM-DD"` formats `15th January, 2017` as `"2017-01-15"`. The default format string comes from the `$Locale` value provider.

This table shows the list of tokens supported in `formatString`.

Description	Token	Output
Day of month	d	1 … 31
Month	M	1 ... 12
Month (short name)	MMM	Jan … Dec
Month (full name)	MMMM	January … December
Year	y	2017
Year (identical to y)	Y	2017
Year (two digit)	YY	17
Year (four digit)	YYYY	2017
Hour of day (1-12)	h	1 … 12
Hour of day (0-23)	H	0 … 23
Hour of day (1-24)	k	1 … 24
Minute	m	0 … 59
Second	s	0 … 59

Description	Token	Output
Fraction of second	SSS	000 ... 999
AM or PM	a	AM or PM
AM or PM (identical to a)	A	AM or PM
Zone offset from UTC	Z	-12:00 ... +14:00
Quarter of year	Q	1 ... 4
Week of year	w	1 ... 53
Week of year (ISO)	W	1 ... 53

There are similar methods that differ in their default output values.

- `formatDateTime()`—The default formatString outputs datetime instead of date.
- `formatDateTimeUTC()`—Formats a datetime in UTC standard time.
- `formatDateUTC()`—Formats a date in UTC standard time.

For more information on all the methods in `AuraLocalizationService`, see the JavaScript API in the Reference Doc App.

Example: Use `$A.localizationService` to use the methods in `AuraLocalizationService`.

```
var now = new Date();
var dateString = "2017-01-15";

// Returns date in the format "Jun 8, 2017"
console.log($A.localizationService.formatDate(now));

// Returns date in the format "Jan 15, 2017"
console.log($A.localizationService.formatDate(dateString));

// Returns date in the format "2017 01 15"
console.log($A.localizationService.formatDate(dateString, "YYYY MM DD"));

// Returns date in the format "June 08 2017, 01:45:49 PM"
console.log($A.localizationService.formatDate(now, "MMMM DD YYYY, hh:mm:ss a"));

// Returns date in the format "Jun 08 2017, 01:48:26 PM"
console.log($A.localizationService.formatDate(now, "MMM DD YYYY, hh:mm:ss a"));
```

SEE ALSO:

Localization

Using JavaScript Promises

You can use ES6 Promises in JavaScript code. Promises can simplify code that handles the success or failure of asynchronous calls, or code that chains together multiple asynchronous calls.

If the browser doesn't provide a native version, the framework uses a polyfill so that promises work in all browsers supported for Lightning Experience.

We assume that you are familiar with the fundamentals of promises. For a great introduction to promises, see https://developers.google.com/web/fundamentals/getting-started/primers/promises.

Promises are an optional feature. Some people love them, some don't. Use them if they make sense for your use case.

Create a Promise

This `firstPromise` function returns a Promise.

```
firstPromise : function() {
    return new Promise($A.getCallback(function(resolve, reject) {
      // do something

      if (/* success */) {
        resolve("Resolved");
      }
      else {
        reject("Rejected");
      }
    }));
}
```

The promise constructor determines the conditions for calling `resolve()` or `reject()` on the promise.

Chaining Promises

When you need to coordinate or chain together multiple callbacks, promises can be useful. The generic pattern is:

```
firstPromise()
    .then(
        // resolve handler
        $A.getCallback(function(result) {
            return anotherPromise();
        }),

        // reject handler
        $A.getCallback(function(error) {
            console.log("Promise was rejected: ", error);
            return errorRecoveryPromise();
        })
    )
    .then(
        // resolve handler
        $A.getCallback(function() {
            return yetAnotherPromise();
        })
    );
```

The `then()` method chains multiple promises. In this example, each resolve handler returns another promise.

`then()` is part of the Promises API. It takes two arguments:

1. A callback for a fulfilled promise (resolve handler)

2. A callback for a rejected promise (reject handler)

The first callback, `function(result)`, is called when `resolve()` is called in the promise constructor. The `result` object in the callback is the object passed as the argument to `resolve()`.

The second callback, `function(error)`, is called when `reject()` is called in the promise constructor. The `error` object in the callback is the object passed as the argument to `reject()`.

Note: The two callbacks are wrapped by `$A.getCallback()` in our example. What's that all about? Promises execute their resolve and reject functions asynchronously so the code is outside the Aura event loop and normal rendering lifecycle. If the resolve or reject code makes any calls to Aura, such as setting a component attribute, use `$A.getCallback()` to wrap the code. For more information, see Modifying Components Outside the Framework Lifecycle on page 189.

Always Use `catch()` or a Reject Handler

The reject handler in the first `then()` method returns a promise with `errorRecoveryPromise()`. Reject handlers are often used "midstream" in a promise chain to trigger an error recovery mechanism.

The Promises API includes a `catch()` method to optionally catch unhandled errors. Always include a reject handler or a `catch()` method in your promise chain.

Throwing an error in a promise doesn't trigger `window.onerror`, which is where the framework configures its global error handler. If you don't have a `catch()` method, keep an eye on your browser's console during development for reports about uncaught errors in a promise. To show an error message in a `catch()` method, use `$A.reportError()`. The syntax for `catch()` is:

```
promise.then(...)
    .catch(function(error) {
        $A.reportError("error message here", error);
    });
```

For more information on `catch()`, see the Mozilla Developer Network.

Don't Use Storable Actions in Promises

The framework stores the response for storable actions in client-side cache. This stored response can dramatically improve the performance of your app and allow offline usage for devices that temporarily don't have a network connection. Storable actions are only suitable for read-only actions.

Storable actions might have their callbacks invoked more than once: first with cached data, then with updated data from the server. The multiple invocations don't align well with promises, which are expected to resolve or reject only once.

Using Promises in Tests

You can return a promise from the current test stage and the test framework will wait for that promise to resolve or reject before continuing to the next test stage or completing the test. You don't need any boilerplate code to handle errors or wait for promises to complete.

Here's an example:

```
testThatUsesPromises: {
    test: function(cmp) {
        return somePromise()
            .then(function() {
                return anotherPromise();
```

```
            });
        }
}
```

SEE ALSO:

Storable Actions

Making API Calls

You can make API calls from client-side code, but it's not a best practice. Make API calls from server-side controllers instead to maximize performance.

The framework uses an `XMLHttpRequest` (XHR) to communicate from the client to the server and server-side actions are designed to minimize network traffic and provide a smoother user experience.

Batching of Actions

The framework queues up actions before sending them to the server. This mechanism is largely transparent to you when you're writing code but it enables the framework to minimize network traffic by batching multiple actions into one request (XHR). For more information, see Queueing of Server-Side Actions on page 222.

Abortable Actions

Mark an action as abortable to make it potentially abortable while it's queued to be sent to the server. An abortable action in the queue is not sent to the server if the component that created the action is no longer valid, that is `cmp.isValid() == false`. A component is automatically destroyed and marked invalid by the framework when it is unrendered. For more information, see Abortable Actions on page 227.

Storable Actions

Enhance your component's performance by marking actions as storable to quickly show cached data from client-side storage without waiting for a server trip. If the cached data is stale, the framework retrieves the latest data from the server. Caching is especially beneficial for users on high latency, slow, or unreliable connections such as 3G networks. For more information, see Storable Actions on page 224.

Background Actions

An action can be marked as a background action. This is useful when you want your app to remain responsive to a user while it executes a low priority, long-running action. A rough guideline is to use a background action if it takes more than five seconds for the response to return from the server. For more information, see Foreground and Background Actions on page 223.

CHAPTER 9 Using Java

In this chapter ...

Use Java to write server-side Aura code. Services are the API in front of Aura. The `Aura` class is the entry point in Java for accessing server-side services.

Your app can contain the following types of Java files.

- Models for initializing component data
- Server-side controllers for handling requests from client-side controllers
- Server-Side Providers for returning a concrete component at runtime for an abstract component or an interface in markup

SEE ALSO:

Java Models

Creating Server-Side Logic with Controllers

Server-Side Runtime Binding of Components

Component Request Lifecycle

Using Object-Oriented Development

Essential Terminology

When you write Java code in Aura, it's essential to understand some basic concepts of the framework.

Term	Description
Definition	Each definition describes metadata for an element, such as a component, event, controller, or model. A large part of Aura is a registry of definitions for its various elements. A definition's metadata can include a name, location of origin, and descriptor (DefDescriptor, the primary key of the definition).
DefDescriptor	A DefDescriptor acts as a key for a definition in a registry. It's an Aura class that contains the metadata for any definition used in Aura, such as a component, action, or event. In the example of a model, it is a nicely parsed description of `model="java://myPackage.MyClass"` with methods to retrieve the language, class name, and package name. Rather than passing a more heavyweight definition around in code, Aura usually passes around a DefDescriptor instead. The qualified name for a DefDescriptor has a format of either `prefix://namespace:name` or `prefix://namespace.name`. For example, `js://ui.button`. • prefix: Defines the language, such as JavaScript or Java • namespace: Corresponds to the package name or XML namespace • name: Corresponds to the class name or local name
Instance	An instance represents the data for a component, event, or action. The component data is contained in its model and attributes.
Registry	Registries store metadata definitions. Some registries last for the duration of a request, while others are cached for the lifetime of the app server. They may be created during the request process and destroyed when the server completes the request. A master definition registry contains a list of registries for each Aura resource.

Reading Initial Component Data with Models

Use a model to read your initial component data and display the data on the user interface. Aura's model is more of a model initializer compared to the usage of models in other MVC frameworks. The model is instantiated when the component is first requested.

> **Note:** Models are deprecated. A model is bad for performance because it limits the framework's capability to cache components, and requires a server request to create the component. The server round-trip slows down component creation and also means that the component can't be used offline.
>
> Instead of using models, fetch data asynchronously in a component's init handler. While the data is being asynchronously fetched, you can render the rest of the component, perhaps with a placeholder, and fill in the data later. This progressive rendering improves perceived performance.

You can create a model using Java or JSON. For example, a Java model could read the component's data from a database. A JSON model reads your initial component data from a JSON resource.

Java Models

Use a Java model to read a component's data from a dynamic source, such as a database.

Note: Models are deprecated. A model is bad for performance because it limits the framework's capability to cache components, and requires a server request to create the component. The server round-trip slows down component creation and also means that the component can't be used offline.

Instead of using models, fetch data asynchronously in a component's init handler. While the data is being asynchronously fetched, you can render the rest of the component, perhaps with a placeholder, and fill in the data later. This progressive rendering improves perceived performance.

The value provider for a model is denoted by `m`. For example, the label in this button component is retrieved from the model of the component containing the `<ui:button>` tag. The value for the label is evaluated when the component renders.

```
<ui:button label="{!m.myLabel}"/>
```

On the server side, Aura's model is more of a model initializer compared to the usage of models in other MVC frameworks. The model is instantiated when the component is first requested. Perform any necessary operations to gather state, such as making database queries or external API callouts, in the model's constructor.

When the component is serialized to the client, the `@AuraEnabled` getters are executed, and their results are serialized as name-value pairs. This serialized map becomes the basis for the initial state of the model on the client.

Note: You can't create a new component dynamically in a model class using `Aura.getInstanceService().getInstance()`.

Wiring Up the Model

The `aura:component` tag contains a `model` system attribute that wires it to the Java model. For example:

```
<aura:component model="java://org.auraframework.demo.notes.models.TrivialModel">
```

Accessing the Model in Markup

Let's look at simple usage of a model in the markup of a component.

```
<aura:component model="java://org.auraframework.demo.notes.models.TrivialModel">
    <aura:attribute name="name" type="String" required="true" default="Michelle" />

    <!-- Use the "m." prefix to access any fields that are annotated with
    @AuraEnabled in the model class -->
    <h1>Title : {!m.title}</h1>

    <!-- Use v.name to directly access the component's name attribute.
        Remember that you use v to access the component's attribute values -->
    <h2>Name : {!v.name}</h2>
</aura:component>
```

The `{!m.title}` expression returns the result of the `getTitle()` getter method in the component's model class. The `getTitle()` method must be prefixed with the `@AuraEnabled` annotation.

Java Model class

This model is simple as it doesn't read in data from a persistent data store but it demonstrates some basics, including accessing a component's attribute in the model.

```
package org.auraframework.demo.models;

import org.auraframework.instance.BaseComponent;
import org.auraframework.system.Annotations.AuraEnabled;
import org.auraframework.system.Annotations.Model;
import org.auraframework.throwable.quickfix.QuickFixException;

@Model
public class TrivialModel
{
    private String title;

    // The constructor is called during the construction of each instance of the model
    // The constructor must be public
    public TrivialModel() {
       // This retrieves the component for this model as a Java object
       BaseComponent cmp =
      Aura.getContextService().getCurrentContext().getCurrentComponent();

       // Retrieve the name attribute of the component
       String name = (String)cmp.get("v.name");

       /* Do any queries or data generation in the constructor of your model.
        * In this sample, we have a trivial initialization for the title field.
        * A real-world scenario would read the data from a persistent data store. */
       title = "Welcome to " + name;
    }

    // Use @AuraEnabled to enable client- and server-side access to the title field
    @AuraEnabled
    public String getTitle() {
       return title;
    }
}
```

Java Annotations

These annotations are available in Java models.

Annotation	Description
`@Model`	Denotes that a Java class is a model.
`@AuraEnabled`	Enables client- and server-side access to a getter method. This means that you only expose data that you have explicitly annotated

Annotation	Description
	and avoids accidentally exposing fields. Other fields are not available.

SEE ALSO:

JSON Models
Accessing Models in JavaScript
Creating Server-Side Logic with Controllers
Server-Side Runtime Binding of Components
Mocking Java Models

JSON Models

Use a JSON model to read your initial component data from a JSON resource.

Note: Models are deprecated. Instead of using models, fetch data asynchronously in a component's init handler. While the data is being asynchronously fetched, you can render the rest of the component, perhaps with a placeholder, and fill in the data later. This progressive rendering improves perceived performance.

Wiring Up the Model

There are a few ways to wire up a JSON model. A JSON model is auto-wired if it's in the component bundle and follows the naming convention, `<componentName>Model.js`.

You can explicitly declare a model in the `aura:component` tag by including a `model` system attribute with the format `model="js://<namespace>.<componentName>"`. This enables reuse of a model from another component. For example, this component uses the auto-wired model for `auradocs.sampleComponent` in `auradocs/sampleComponent/sampleComponentModel.js`.

```
<aura:component model="js://auradocs.sampleComponent
```

If you explicitly declare a `model` system attribute, it takes precedence over a model in the component bundle.

Note: A component can only have a JSON or Java model, but not both.

Sample JSON Model

Here is a sample JSON model.

```
{
    "bool" : true,
    "num" : 5,
    "str" : "My name is JSON",
    "list" : []
}
```

Note: Don't use `null` for model values. Use `[]` for an empty array, `""` for an empty string, or zero for a number. This enables the framework to determine which type of value wrapper to initialize. Due to a current limitation, don't use `{}` for an empty object.

Accessing the Model in Markup

Here is simple usage of a model in the markup of a component.

```
<-- This component uses an auto-wired model
    as this aura:component tag has no model system attribute -->
<aura:component>
    boolean: {!m.bool}
    number: {!m.num}
    string: {!m.str}
    list length: {!m.list.length}
</aura:component>
```

SEE ALSO:

Java Models
Accessing Models in JavaScript
Component Bundles

Accessing Models in JavaScript

Use the value provider, `m`, to access a Java or JSON model in JavaScript code. For example:

```
var title = cmp.get("m.title");
alert("Title: " + title);
```

To update the model in JavaScript code, use `set()`. For example:

```
cmp.set("m.myLabel", "updated label");
```

SEE ALSO:

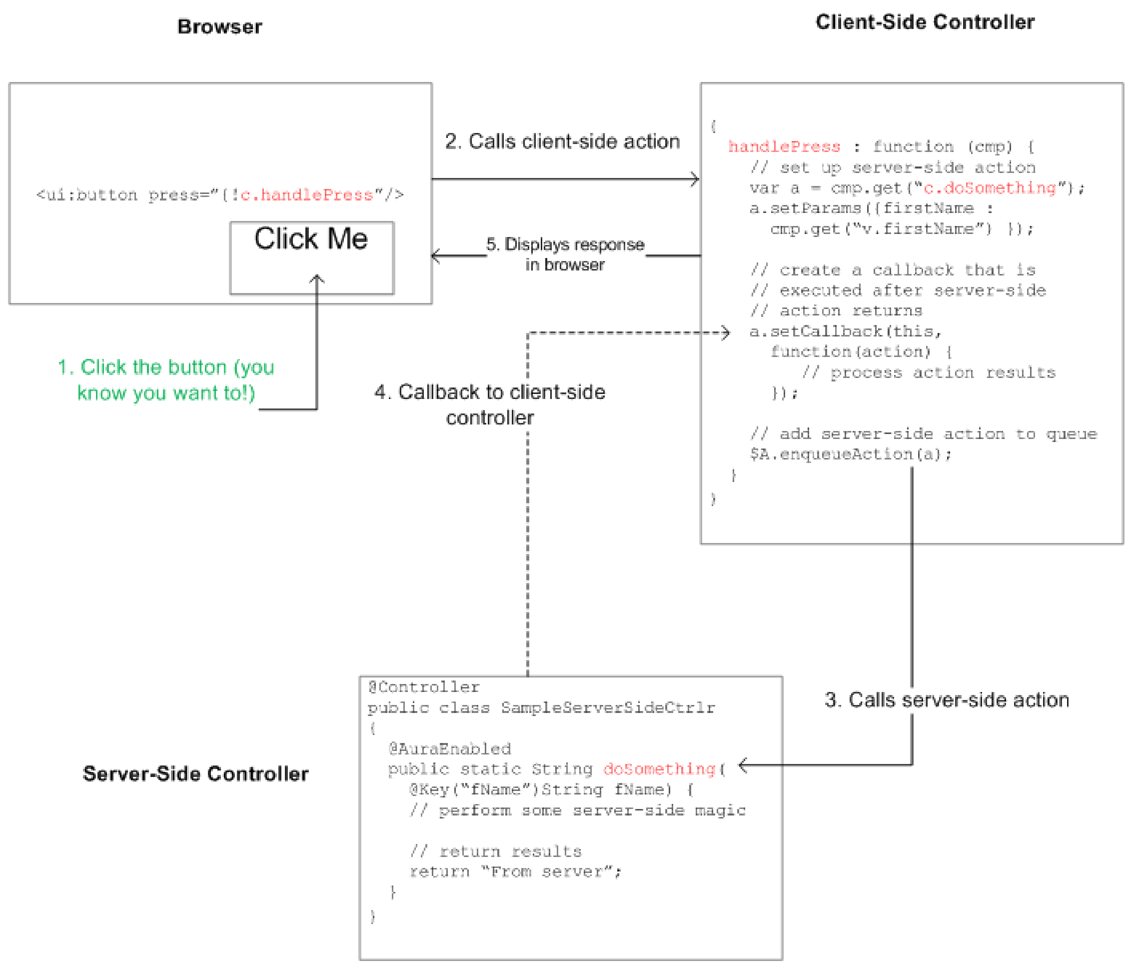
Java Models
JSON Models
Working with Attribute Values in JavaScript

Creating Server-Side Logic with Controllers

The framework supports client-side and server-side controllers. An event is always wired to a client-side controller action, which can in turn call a server-side controller action. For example, a client-side controller might handle an event and call a server-side controller action to persist data to a database.

Server-side actions need to make a round trip, from the client to the server and back again, so they usually complete more slowly than client-side actions.

This diagram shows the flow from browser to client-side controller to server-side controller.



The `press` attribute wires the button to the `handlePress` action of the client-side controller by using `c.handlePress`. The client-side action name must match everything after the `c.`

For more details on the process of calling a server-side action, see Calling a Server-Side Action on page 219.

IN THIS SECTION:

Storable Actions

Enhance your component's performance by marking actions as storable to quickly show cached data from client-side storage without waiting for a server trip. If the cached data is stale, the framework retrieves the latest data from the server. Caching is especially beneficial for users on high latency, slow, or unreliable connections such as 3G networks.

Abortable Actions

Mark an action as abortable to make it potentially abortable while it's queued to be sent to the server. An abortable action in the queue is not sent to the server if the component that created the action is no longer valid, that is `cmp.isValid() == false`. A component is automatically destroyed and marked invalid by the framework when it is unrendered.

Caboose Actions

Use a caboose server action to send data to the server that is not time-sensitive, such as logging, performance statistics, or click tracking data.

Creating a Java Server-Side Controller

Create a server-side controller in Java. A component must include a `controller` attribute that wires it to the server-side Java controller.

Here's a sample Java controller that contains a `serverEcho` action that simply prepends a string to the value passed in. This is a simple example that allows us to verify in the client that the value was returned by the server.

```
package org.auraframework.demo.controllers;

@ServiceComponent
public class SimpleServerSideController implements Controller
{

    //Use @AuraEnabled to enable client- and server-side access to the method
    @AuraEnabled
    public static String serverEcho(@Key("firstName")String firstName) {
        return ("From server: " + firstName);
    }
}
```

Tip:

- Don't store component state in your controller. Store state in a component's attribute instead.
- Use unique names for client-side and server-side actions in a component. A JavaScript function (client-side action) with the same name as a Java method (server-side action) can lead to hard-to-debug issues. In PRODDEBUG mode, the framework logs a browser console warning about the clashing client-side and server-side action names.

Java Annotations

These Java annotations are available in server-side controllers.

`@ServiceComponent`

Denotes that a Java class is a server-side controller. The class must implement the `Controller` interface too.

`@AuraEnabled`

Enables client- and server-side access to a controller method. This means that you only expose methods that you have explicitly annotated.

@Key

Sets a key for each argument in a method for a server-side action. When you use `setParams` to set parameters in the client-side controller, match the JSON element name with the identifier for the `@Key` annotation. Note that we used `a.setParams({ firstName : component.get("v.firstName") });` in the client-side controller that calls our sample server-side controller.

The `@Key` annotation means that you don't have to create an overloaded version of the method if you want to call it with different numbers of arguments. The framework simply passes in `null` for any unspecified arguments.

You can also indicate which parameters are loggable by setting the optional second attribute, `loggable`, to `true`. This example shows how to specify that the `config` and `pageSize` parameters should be included in the log:

```
public static Map<String, Object> refreshFeed(
  @Key(value = "config", loggable = true) Object config,
  @Key(value = "pageSize", loggable = true) Integer pageSize)
    throws SQLException {
        ...
}
```

@BackgroundAction

Marks the action as a background action.

Wiring Up a Java Server-Side Controller

The component must include a `controller` attribute that wires it to the server-side Java controller. For example:

```
<aura:component
controller="java://org.auraframework.demo.controllers.SimpleServerSideController">
```

SEE ALSO:

Foreground and Background Actions

Component Markup

Calling a Server-Side Action

Call a server-side controller action from a client-side controller. In the client-side controller, you set a callback, which is called after the server-side action is completed. A server-side action can return any object containing serializable JSON data.

A client-side controller is a JavaScript object in object-literal notation containing a map of name-value pairs.

Let's say that you want to trigger a server-call from a component. The following component contains a button that's wired to a client-side controller `echo` action. `SimpleServerSideController` contains a method that returns a string passed in from the client-side controller.

```
<aura:component
controller="java://org.auraframework.demo.controllers.SimpleServerSideController">
    <aura:attribute name="firstName" type="String" default="world"/>
    <lightning:button label="Call server" onclick="{!c.echo}"/>
</aura:component>
```

This client-side controller includes an `echo` action that executes a `serverEcho` method on a server-side controller.

Tip: Use unique names for client-side and server-side actions in a component. A JavaScript function (client-side action) with the same name as a Java method (server-side action) can lead to hard-to-debug issues. In PRODDEBUG mode, the framework logs a browser console warning about the clashing client-side and server-side action names.

```
({
    "echo" : function(cmp) {
        // create a one-time use instance of the serverEcho action
        // in the server-side controller
        var action = cmp.get("c.serverEcho");
        action.setParams({ firstName : cmp.get("v.firstName") });

        // Create a callback that is executed after
        // the server-side action returns
        action.setCallback(this, function(response) {
            var state = response.getState();
            if (state === "SUCCESS") {
                // Alert the user with the value returned
                // from the server
                alert("From server: " + response.getReturnValue());

                // You would typically fire a event here to trigger
                // client-side notification that the server-side
                // action is complete
            }
            else if (state === "INCOMPLETE") {
                // do something
            }
            else if (state === "ERROR") {
                var errors = response.getError();
                if (errors) {
                    if (errors[0] && errors[0].message) {
                        console.log("Error message: " +
                                 errors[0].message);
                    }
                } else {
                    console.log("Unknown error");
                }
            }
        });

        // optionally set storable, abortable, background flag here

        // A client-side action could cause multiple events,
        // which could trigger other events and
        // other server-side action calls.
        // $A.enqueueAction adds the server-side action to the queue.
        $A.enqueueAction(action);
    }
})
```

In the client-side controller, we use the value provider of `c` to invoke a server-side controller action. We also use the `c` syntax in markup to invoke a client-side controller action.

The `cmp.get("c.serverEcho")` call indicates that we're calling the `serverEcho` method in the server-side controller. The method name in the server-side controller must match everything after the `c.` in the client-side call. In this case, that's `serverEcho`.

Use `action.setParams()` to set data to be passed to the server-side controller. The following call sets the value of the `firstName` argument on the server-side controller's `serverEcho` method based on the `firstName` attribute value.

```
action.setParams({ firstName : cmp.get("v.firstName") });
```

`action.setCallback()` sets a callback action that is invoked after the server-side action returns.

```
action.setCallback(this, function(response) { ... });
```

The server-side action results are available in the `response` variable, which is the argument of the callback.

`response.getState()` gets the state of the action returned from the server.

Note: You don't need a `cmp.isValid()` check in the callback in a client-side controller when you reference the component associated with the client-side controller. The framework automatically checks that the component is valid.

`response.getReturnValue()` gets the value returned from the server. In this example, the callback function alerts the user with the value returned from the server.

`$A.enqueueAction(action)` adds the server-side controller action to the queue of actions to be executed. All actions that are enqueued will run at the end of the event loop. Rather than sending a separate request for each individual action, the framework processes the event chain and batches the actions in the queue into one request. The actions are asynchronous and have callbacks. The `runAfter` method is deprecated.

Tip: If your action is not executing, make sure that you're not executing code outside the framework's normal rerendering lifecycle. For example, if you use `window.setTimeout()` in an event handler to execute some logic after a time delay, wrap your code in `$A.getCallback()`. You don't need to use `$A.getCallback()` if your code is executed as part of the framework's call stack; for example, your code is handling an event or in the callback for a server-side controller action.

Client Payload Data Limit

Use `action.setParams()` to set data for an action to be passed to a server-side controller.

The framework batches the actions in the queue into one server request. The request payload includes all of the actions and their data serialized into JSON. The request payload limit is 4 MB.

IN THIS SECTION:

Action States

Call a server-side controller action from a client-side controller. The action can have different states during processing.

SEE ALSO:

Handling Events with Client-Side Controllers

Queueing of Server-Side Actions

Action States

Checking Component Validity

Action States

Call a server-side controller action from a client-side controller. The action can have different states during processing.

The possible action states are:

NEW

The action was created but is not in progress yet

RUNNING

The action is in progress

SUCCESS

The action executed successfully

ERROR

The server returned an error

INCOMPLETE

The server didn't return a response. The server might be down or the client might be offline. The framework guarantees that an action's callback is always invoked as long as the component is valid. If the socket to the server is never successfully opened, or closes abruptly, or any other network error occurs, the XHR resolves and the callback is invoked with state equal to `INCOMPLETE`.

ABORTED

The action was aborted. This action state is deprecated. A callback for an aborted action is never executed so you can't do anything to handle this state.

SEE ALSO:

Calling a Server-Side Action

Queueing of Server-Side Actions

The framework queues up actions before sending them to the server. This mechanism is largely transparent to you when you're writing code but it enables the framework to minimize network traffic by batching multiple actions into one request (XHR).

The batching of actions is also known as *boxcar'ing*, similar to a train that couples boxcars together.

The framework uses a stack to keep track of the actions to send to the server. When the browser finishes processing events and JavaScript on the client, the enqueued actions on the stack are sent to the server in a batch.

Tip: If your action is not executing, make sure that you're not executing code outside the framework's normal rerendering lifecycle. For example, if you use `window.setTimeout()` in an event handler to execute some logic after a time delay, wrap your code in `$A.getCallback()`.

There are some properties that you can set on an action to influence how the framework manages the action while it's in the queue waiting to be sent to the server. For more information, see:

- Foreground and Background Actions on page 223
- Storable Actions on page 224
- Abortable Actions on page 227
- Caboose Actions on page 228

SEE ALSO:

Modifying Components Outside the Framework Lifecycle

Foreground and Background Actions

Foreground actions are the default. An action can be marked as a background action. This is useful when you want your app to remain responsive to a user while it executes a low priority, long-running action. A rough guideline is to use a background action if it takes more than five seconds for the response to return from the server.

Batching of Actions

Multiple queued foreground actions are batched in a single request (XHR) to minimize network traffic. The batching of actions is also known as *boxcar'ing*, similar to a train that couples boxcars together.

The server sends the XHR response to the client when all actions have been processed on the server. If a long-running action is in the boxcar, the XHR response is held until that long-running action completes. Marking an action as background results in that action being sent separately from any foreground actions. The separate transmission ensures that the background action doesn't impact the response time of the foreground actions.

When the server-side actions in the queue are executed, the foreground actions execute first and then the background actions execute. Background actions run in parallel with foreground actions and responses of foreground and background actions may come back in either order.

We don't make any guarantees for the order of execution of action callbacks. XHR responses may return in a different order than the order in which the XHR requests were sent due to server processing time.

Note: Don't rely on each background action being sent in its own request as that behavior isn't guaranteed and it can lead to performance issues. Remember that the motivation for background actions is to isolate long-running requests into a separate request to avoid slowing the response for foreground actions.

If two actions must be executed sequentially, the component must orchestrate the ordering. The component can enqueue the first action. In the first action's callback, the component can then enqueue the second action.

Framework-Managed Request Throttling

The framework throttles foreground and background requests separately. This means that the framework can control the number of foreground requests and the number of background actions running at any time. The framework automatically throttles requests and it's not user controlled. The framework manages the number of foreground and background XHRs, which varies depending on available resources.

Even with separate throttling, background actions might affect performance in some conditions, such as an excessive number of requests to the server.

Setting Background Actions

To set an action as a background action, call the `setBackground()` method on the action object in JavaScript.

```
// set up the server-action action
var action = cmp.get("c.serverEcho");
// optionally set actions params
//action.setParams({ firstName : cmp.get("v.firstName") });
// set as a background action
action.setBackground();
```

Note: A background action can't be set back to a foreground action. In other words, calling `setBackground` to set it to `false` will have no effect.

To mark a server-side action as a background action in Java, use the `@BackgroundAction` annotation at the method level on the controller. If you set `@BackgroundAction` in Java, you don't need to set `action.setBackground()` in JavaScript code.

SEE ALSO:
Queueing of Server-Side Actions
Calling a Server-Side Action
Creating a Java Server-Side Controller

Storable Actions

Enhance your component's performance by marking actions as storable to quickly show cached data from client-side storage without waiting for a server trip. If the cached data is stale, the framework retrieves the latest data from the server. Caching is especially beneficial for users on high latency, slow, or unreliable connections such as 3G networks.

Warning:

- A storable action might result in no call to the server. Never mark as storable an action that updates or deletes data.
- For storable actions in the cache, the framework returns the cached response immediately and also refreshes the data if it's stale. Therefore, storable actions might have their callbacks invoked more than once: first with cached data, then with updated data from the server.

Most server requests are read-only and idempotent, which means that a request can be repeated or retried as often as necessary without causing data changes. The responses to idempotent actions can be cached and quickly reused for subsequent identical actions. For storable actions, the key for determining an identical action is a combination of:

- Java controller name
- Method name
- Method parameter values

Marking an Action as Storable

To mark a server-side action as storable, call `setStorable()` on the action in JavaScript code, as follows.

```
action.setStorable();
```

Note: Storable actions are always implicitly marked as abortable too.

The `setStorable` function takes an optional argument, which is a configuration map of key-value pairs representing the storage options and values to set. You can only set the following property:

`ignoreExisting`

Set to `true` to bypass the cache. The default value is `false`.

This property is useful when you know that any cached data is invalid, such as after a record modification. This property should be used rarely because it explicitly defeats caching.

To set the storage options for the action response, pass this configuration map into `setStorable(`***`configObj`***`)`.

IN THIS SECTION:
Lifecycle of Storable Actions
This image describes the sequence of callback execution for storable actions.

[Enable Storable Actions in an Application](#)

To use storable actions in a standalone app (`.app` resource), you must configure client-side storage for cached action responses.

SEE ALSO:

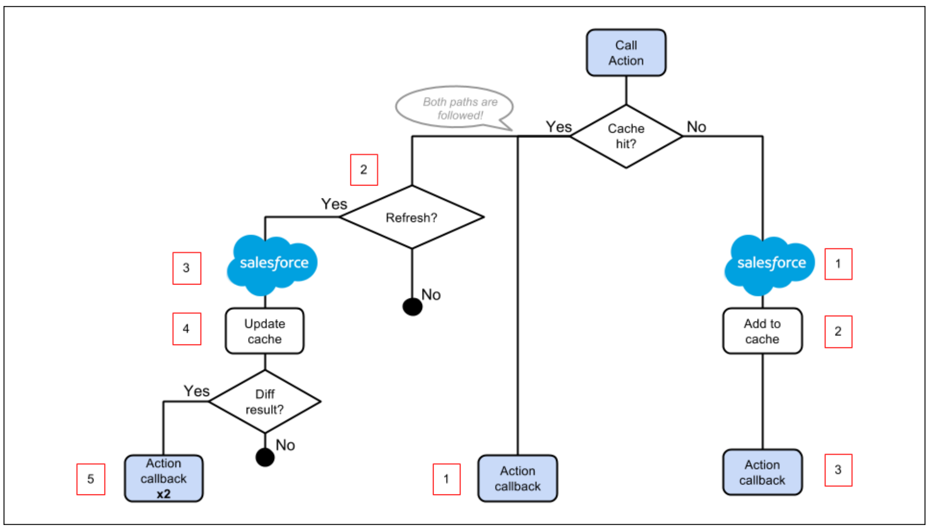
Calling a Server-Side Action
Lifecycle of Storable Actions
Creating Server-Side Logic with Controllers
Abortable Actions

Lifecycle of Storable Actions

This image describes the sequence of callback execution for storable actions.

Note: An action might have its callback invoked more than once:

- First with the cached response, if it's in storage.
- Second with updated data from the server, if the stored response has exceeded the time to refresh entries.



Cache Miss

If the action is not a cache hit as it doesn't match a storage entry:

1. The action is sent to the server-side controller.
2. If the response is `SUCCESS`, the response is added to storage.
3. The callback in the client-side controller is executed.

   The `Action` object in JavaScript provides methods to determine if the response is from storage or if it's the result of a storage refresh.

```
action.isFromStorage()     // returns false
action.isRefreshAction()   // returns false
```

Cache Hit

If the action is a cache hit as it matches a storage entry:

1. The callback in the client-side controller is executed with the cached action response.

   The `Action` object returns these values:

   ```
   action.isFromStorage()     // returns true
   action.isRefreshAction()   // returns false
   ```

2. If the response has been cached for longer than the refresh time, the storage entry is refreshed.

   When an application enables storable actions, a refresh time is configured. The refresh time is the duration in seconds before an entry is refreshed in storage. The refresh time is automatically configured in Lightning Experience and the Salesforce mobile app.

3. The action is sent to the server-side controller.
4. If the response is `SUCCESS`, the response is added to storage.
5. If the refreshed response is different from the cached response, the callback in the client-side controller is executed for a second time.

   The `Action` object returns these values:

   ```
   action.isFromStorage()     // returns false
   action.isRefreshAction()   // returns true
   ```

SEE ALSO:

Storable Actions

Enable Storable Actions in an Application

Enable Storable Actions in an Application

To use storable actions in a standalone app (`.app` resource), you must configure client-side storage for cached action responses.

To configure client-side storage for your standalone app, use `<auraStorage:init>` in the `auraPreInitBlock` attribute of your application's template. For example:

```
<aura:component isTemplate="true" extends="aura:template">
    <aura:set attribute="auraPreInitBlock">
        <auraStorage:init
          name="actions"
          persistent="false"
          secure="true"
          maxSize="1024"
          defaultExpiration="900"
          defaultAutoRefreshInterval="30" />
    </aura:set>
</aura:component>
```

`name`
   The name for the storage instance.

`persistent`
   Set to `true` to preserve cached data between user sessions in the browser.

`secure`
Set to `true` to encrypt cached data.

`maxsize`
The maximum size in KB of the storage.

`defaultExpiration`
The duration in seconds that an entry is retained in storage.

`defaultAutoRefreshInterval`
The duration in seconds before an entry is refreshed in storage.

Storable actions use the Storage Service. The Storage Service supports multiple implementations of storage and selects an adapter at runtime based on browser support and specified characteristics of persistence and security.

SEE ALSO:

Initializing Storage Service

Storage Service Adapters

Abortable Actions

Mark an action as abortable to make it potentially abortable while it's queued to be sent to the server. An abortable action in the queue is not sent to the server if the component that created the action is no longer valid, that is `cmp.isValid() == false`. A component is automatically destroyed and marked invalid by the framework when it is unrendered.

Note: We recommend that you only use abortable actions for read-only operations as they are not guaranteed to be sent to the server.

An abortable action is sent to the server and executed normally unless the component that created the action is invalid before the action is sent to the server.

A non-abortable action is always sent to the server and can't be aborted in the queue.

If an action response returns from the server and the associated component is now invalid, the logic has been executed on the server but the action callback isn't executed. This is true whether or not the action is marked as abortable.

Marking an Action as Abortable

Mark a server-side action as abortable by using the `setAbortable()` method on the `Action` object in JavaScript. For example:

```
var action = cmp.get("c.serverEcho");
action.setAbortable();
```

SEE ALSO:

Creating Server-Side Logic with Controllers

Queueing of Server-Side Actions

Calling a Server-Side Action

Caboose Actions

Use a caboose server action to send data to the server that is not time-sensitive, such as logging, performance statistics, or click tracking data.

A caboose action waits until another non-caboose foreground action is sent and will piggyback on that `XMLHttpRequest (XHR)`. This can improve performance by eliminating the overhead of additional round trips to the server.

If no other actions trigger an XHR to be sent to the server within 60 seconds, any pending caboose actions are batched into their own XHR. The 60-seconds countdown starts when a caboose action is enqueued. The caboose action is sent the next time the framework processes any events after the countdown elapses.

Note: If there is a caboose action in the queue when a user closes the app, that caboose action will not be sent.

Marking Caboose Actions

When you generate data on the client that you want to send to the server, mark a foreground action as a caboose action with `action.setCaboose()`, set a callback with `setAllAboardCallback()`, and enqueue the action using `$A.enqueueAction()`. The `setAllAboardCallback()` callback is called just before the action is sent to the server, just like an "all aboard" announcement before a train leaves a station.

To implement a log and flush pattern, the callback should use one or more calls to `setParam()` on the action to set the data to be sent. The server-side action should then process the data that was sent as parameters.

This sample code in a helper adds log data to a data queue. The caboose action contains the log data and flushes the client-side data queue just before the action is sent to the server.

```
({
    initFields : function(component) {
        /**
         * A queue of log data objects
         */
        this.dataQueue = [];
    },

    /**
     * Add log data to the data queue
     *
     * @param {!string} key App analytics handler key
     * @param {!Object} data App analytics data
     */
    doCaboose : function(key, data) {
        // if data queue is empty, set up caboose action
        if (this.dataQueue.length == 0) {
            // set server-side action
            // serverHandle is a method in the server-side controller
            // that processes the data. The server-side code is not shown here.
            var action = component.get('c.serverHandle');
            action.setAllAboardCallback(this,
                    this.flushDataQueue);
            action.setCaboose();
            $A.enqueueAction(action);
        }
        var logData = {};
        logData[key] = data;
```

```
        this.dataQueue.push(logData);
    },

    /**
     * Send the queue to the server and then reset the queue
     *
     * @param {!Object} action Caboose action that is about to be sent to the server
     */
    flushDataQueue : function(action) {
        var batchedData = this.dataQueue;
        this.dataQueue = [];
        action.setParam('batch', batchedData);
    }
})
```

SEE ALSO:

Queueing of Server-Side Actions

Calling a Server-Side Action

Server-Side Rendering to the DOM

The Aura rendering service takes in-memory component state and updates the component in the Document Object Model (DOM).

The DOM is the language-independent model for representing and interacting with objects in HTML and XML documents. Aura automatically renders your components so you don't have to know anything more about rendering unless you need to customize the default rendering behavior for a component.

Note: The preferred way to customize component rendering is to use a client-side renderer. You can also use a server-side renderer but it's not recommended as they don't degrade gracefully if an error, such as a network connection outage, occurs. The framework uses a server-side renderer to render an app's template and that is the primary use case for rendering on the server.

Creating a Java Server-Side Renderer

If you've exhausted the alternatives, including a client-side renderer, create a server-side renderer in Java by implementing the `org.auraframework.def.Renderer` interface. The interface contains one method:

```
public void render(BaseComponent<?,?> component, Appendable appendable)
        throws IOException, QuickFixException;
```

The `component` argument is the instance to render. The `appendable` argument is the output buffer.

The class that implements the interface must have a no-argument constructor. The class is instantiated as a singleton, so no state should be stored in it.

Wiring Up a Server-Side Renderer

To wire up a server-side renderer for a component, add a `renderer` system attribute in `<aura:component>`. For example:

```
<aura:component
renderer="java://org.auraframework.demo.notes.renderers.ReallyNeedAServerSideRenderer">
```

```
    ...
</aura:component>
```

The framework behavior is undefined if you add a server-side renderer that also includes a client-side renderer. We recommend that you use one or the other.

SEE ALSO:

Create a Custom Renderer
Creating App Templates

Server-Side Runtime Binding of Components

A provider enables you to use an abstract component in markup. The framework uses the provider to determine the concrete component to use at runtime.

Server-side providers are more common, but if you don't need to access the server when you're creating a component, you can use a client-side provider instead.

Set the `provider` system attribute in the `<aura:component>` tag of an abstract component to point to the server-side provider Java class.

The syntax of the `provider` system attribute is `provider="java://package.class"` where `package.class` is the fully qualified name for the class.

A Java provider must:

- Include the `@Provider` annotation above the class definition
- Implement either the `ComponentDescriptorProvider` or `ComponentConfigProvider` interface

At runtime, a provider has access to a shell of the abstract component, including any attribute values that have been set. The model isn't constructed yet so you can't access it. The `provide()` method can examine the attribute values that are set on the component, and return a descriptor of the non-abstract component type that should be used.

Note: A provider should only return concrete components that are sub-components of a single base component that implement an interface. Aura doesn't currently enforce this restriction, but it's the preferred pattern. The abstract component that references the provider also extends the base component.

ComponentDescriptorProvider

Use the `ComponentDescriptorProvider` interface to return a `DefDescriptor` describing the concrete component to use when you don't need to set attributes for the component. For example:

```
@Provider
public class SampleDescProvider implements ComponentDescriptorProvider {

    public DefDescriptor<ComponentDef> provide() {
        DefDescriptor defDesc = null;

        // logic to determine DefDescriptor to set and return.

        return defDesc;
    }
}
```

ComponentConfigProvider

Use the `ComponentConfigProvider` interface to return a `ComponentConfig`, which describes the concrete component to use in a DefDescriptor and enables you to set attributes for the component. For example:

```
@Provider
public class SampleConfigProvider implements ComponentConfigProvider {

    public ComponentConfig<ComponentDef> provide() {
        ComponentConfig cmpConfig = null;

        // logic to determine DefDescriptor
        // and attributes to set.

        return cmpConfig;
    }
}
```

Declaring Provider Dependencies

The Aura framework automatically tracks dependencies between definitions, such as components. However, if a component uses a provider that instantiates components that are not directly referenced elsewhere, use `<aura:dependency>` in the component to explicitly tell the framework about the dependency, which wouldn't otherwise be discovered by Aura.

SEE ALSO:
Client-Side Runtime Binding of Components
Abstract Components
Interfaces
Getting a Java Reference to a Definition
aura:dependency
Mocking Java Providers

Serializing Exceptions

You can serialize server-side exceptions and attach an event to be passed back to the client in such a way that an event is automatically fired on the client side and handled by the client's error-handling event handler.

To do this, on the server, instantiate a `GenericEventException` that contains an event and parameters and then throw it. The exception gets serialized and when the action goes back to the client, the exception is sent along with the action as an error on the action. The status of the action will be set as "Error". The specified event in `GenericEventException` will be fired and its handlers invoked. If a callback is provided specifically for the error state, then that callback is invoked. Otherwise, the default callback is invoked.

```
@AuraEnabled
public static void throwsGEE(@Key("event") String event, @Key("paramName") String paramName,

    @Key("paramValue") String paramValue) throws Throwable {
        GenericEventException gee = new GenericEventException(event);
        if (paramName != null) {
            gee.addParam(paramName, paramValue);
```

```
        }
        throw gee;
}
```

On the client, the client-side framework automatically handles deserializing the event and firing it. For a component event, only handlers associated with this component are invoked, else the firing of the event has no effect. For an application event, its global and all event handlers are invoked.

A `GenericEventException` is a server-side Java exception that extends the generic exception, `ClientSideEventException`. Optionally, you can extend `ClientSideEventException` yourself but it is easier to use the provided `GenericEventException`. Other classes that extend `ClientSideEventException` are the `ClientOutOfSyncException` class, the `SystemErrorException` class, the `InvalidSessionException` class, and the `NoAccessException` class. These classes are for internal use only.

For a working example of a server-side controller that throws a `GenericEventException`, refer to the test:testActionEvent component.

SEE ALSO:

Creating Server-Side Logic with Controllers

CHAPTER 10 Java Cookbook

In this chapter ...

This section includes code snippets and samples that can be used in JavaScript classes.

Dynamically Creating Components in Java

You can create a component dynamically in your Java code.

This example demonstrates how to use Java to get an instance of a component. An instance represents the data for a component. Use the `InstanceService` class to create a new component instance.

```
// listAttributes is a map of attributes for the component
Map<String, Object> listAttributes = new HashMap();
listAttributes.put("sort", "asc");
Component cmpInstance =
    Aura.getInstanceService().getInstance("auranote:noteList",
        ComponentDef.class, listAttributes);
```

The first parameter to the `getInstance` method is `auranote:noteList`, which is the qualified name for a `noteList` component in the `auranote` namespace.

The second parameter is `ComponentDef.class`, which indicates the class for the instance.

The third parameter is `listAttributes`, which contains a map of attributes for the component instance. In this case, we only have one `sort` attribute, but you can add more attributes to the map, if needed.

The `InstanceService` class also has other overloaded `getInstance` methods that take either a `Definition` or a `DefDescriptor` as their first parameter instead of a qualified name.

SEE ALSO:

Setting a Component ID

Component Request Glossary

Getting a Java Reference to a Definition

Setting a Component ID

To create a component with a local ID and attributes in Java code, use `ComponentDefRefBuilder` to set the component definition reference.

`ComponentDefRefBuilder` is also known as `ComponentDefRef`. The `ComponentDefRef` creates the definition of the component instance and turns it into an instance of the component during runtime. For example, the `aura:if` component uses `ComponentDefRef` for its `body` and `else` attributes.

```
ComponentDefRefBuilder builder = Aura.getBuilderService().getComponentDefRefBuilder();

//Set the descriptor for your new component
builder.setDescriptor("namespace:newCmp");

//Set the local Id for your new component
builder.setLocalId("newId");

//Set attributes on the new component
builder.setAttribute("attr1", false);
builder.setAttribute("attr2", attrVal);

//Create a new instance of the component
Component aNewCmp = builder.build().newInstance(null).get(0);
```

You can also create an instance of a component using `Aura.getInstanceService().getInstance()`, but you should use the `ComponentDefRefBuilder` if you want to:

- Set an ID on the new component.
- Set a facet on a top-level component.
- Create multiple instances of the components with minimal updates to the definition.

The XML Parser in Aura reads in files, such as `.cmp`, `.intf`, and `.evt`, by using the `BuilderService` to construct definitions. The `BuilderService` doesn't know anything about XML. If you want to create reusable definitions that are the equivalent of what you could type into an XML file, but don't want to use XML as the storage format, use the `BuilderService`.

Note: Although `ComponentDefRef` provides performance benefits, we recommend you to use `AuraComponent[]` instead as `ComponentDefRef` will be deprecated in a later release. During component creation, any items marked as an `AuraComponent[]` type is recursively created. Items that are marked as a `ComponentDefRef` is initialized as a list that contains only the information to create the actual components at a later time. For more information, see Component Request Lifecycle.

SEE ALSO:

Component Facets

Dynamically Creating Components in Java

Component Request Glossary

Server-Side Processing for Component Requests

Getting a Java Reference to a Definition

A definition in Aura describes metadata for an object, such as a component, event, controller, or model. Rather than passing a more heavyweight definition around in code, Aura usually passes around a reference, called a `DefDescriptor`, instead.

In the example of a model, a `DefDescriptor` is a nicely parsed description of `model="java://myPackage.MyClass"` with methods to retrieve the language, class name, and package name.

To create a `DefDescriptor` in Java code, use the `DefinitionService` class to create a new `DefDescriptor`.

```
DefDescriptor<ComponentDef> defDesc =
    Aura.getDefinitionService().getDefDescriptor("ui:button", ComponentDef.class);
```

The first parameter to the `getDefDescriptor` method is `ui:button`, which is the qualified name for a button component in the `ui` namespace. The second parameter is `ComponentDef.class`, which indicates the class for the definition.

SEE ALSO:

Component Request Glossary

CHAPTER 11 Caching with Storage Service

In this chapter ...

- Storage Service Adapters
- Initializing Storage Service
- Using Storage Service

The Storage Service provides a powerful, simple-to-use caching infrastructure that enhances the user experience on the client. Client applications can benefit from caching data to reduce response times of pages by storing and accessing data locally rather than requesting data from the server. Caching is especially beneficial for high-performance, mostly connected applications operating over high latency connections, such as 3G networks.

The storage name is required and must be unique.

There are two types of storage:

- Storable actions: Storable actions cache server action response values. The storage name must be `actions`.
- Custom named storage: Storage that you control by adding and retrieving items to and from storage. The storage name can be any name except for `actions`, which is reserved for caching action response values.

SEE ALSO:

Creating Server-Side Logic with Controllers
Storable Actions
Initializing Storage Service

Storage Service Adapters

The Storage Service supports multiple implementations of storage and selects an adapter at runtime based on browser support and specified characteristics of persistence and security. Storage can be persistent and secure. With persistent storage, cached data is preserved between user sessions in the browser. With secure storage, cached data is encrypted.

Storage Adapter Name	Persistent	Secure
IndexedDB	`true`	`false`
Memory	`false`	`true`

IndexedDB

(Persistent but not secure) Provides access to an API for client-side storage and search of structured data. For more information, see the Indexed Database API.

Memory

(Not persistent but secure) Provides access to JavaScript memory for caching data. The stored cache persists only per browser page. Browsing to a new page resets the cache.

The Storage Service selects a storage adapter on your behalf that matches the persistent and secure options you specify when initializing the service. For example, if you request a persistent and insecure storage service, the Storage Service returns the IndexedDB storage if the browser supports it.

SEE ALSO:

Initializing Storage Service

Initializing Storage Service

Initialize storage in markup or JavaScript by specifying a name and, optionally, other properties.

If you don't specify the optional properties, the Storage Service uses default values set by the `initStorage()` method of AuraStorageService.

Storage Entry Expiration

When you initialize storage, you can configure the expiration time, which is the duration in seconds that an entry is retained in storage.

To set the expiration time in markup, use the `defaultExpiration` attribute in `<auraStorage:init>`.

To set the expiration time in JavaScript, use the `expiration` property in `$A.storageService.initStorage(`***`config`***`)`.

Storage Entry Refresh Interval

When you initialize storage, you can configure the refresh interval, which is the duration in seconds before an entry is refreshed in storage.

If an action matches a storage entry, the callback in the client-side controller is invoked for the cached action response.

If the response has been cached for longer than the refresh interval, the storage entry is refreshed. If the refreshed response is different from the cached response, the callback in the client-side controller is executed for a second time.

To set the refresh interval in markup, use the `defaultAutoRefreshInterval` attribute in `<auraStorage:init>`.

To set the refresh interval in JavaScript, use the `autoRefreshInterval` property in `$A.storageService.initStorage(`***`config`***`)`.

Initialize in Markup

This example uses a template to initialize storage for server-side action response values. The template contains an `<auraStorage:init>` tag that specifies storage initialization properties.

```
<aura:component isTemplate="true" extends="aura:template">
    <aura:set attribute="auraPreInitBlock">
        <auraStorage:init
          name="actions"
          persistent="false"
          secure="true"
          maxSize="1024"
          defaultExpiration="900"
          defaultAutoRefreshInterval="30" />
    </aura:set>
</aura:component>
```

`name`
The name for the storage instance.

`persistent`
Set to `true` to preserve cached data between user sessions in the browser.

`secure`
Set to `true` to encrypt cached data.

`maxsize`
The maximum size in KB of the storage.

`defaultExpiration`
The duration in seconds that an entry is retained in storage.

`defaultAutoRefreshInterval`
The duration in seconds before an entry is refreshed in storage.

Initialize in JavaScript

Initialize storage dynamically using the JavaScript API. This example shows how to initialize the Storage Service using `initStorage(`***`config`***`)` in a JavaScript client-side controller.

```
var storage = $A.storageService.initStorage({
    "name":                 "MyStorage",
    "persistent":           true,
    "secure":               true,
    "maxSize":              524288, // (bytes) (512 * 1024)
    "expiration":           900,    // (seconds)
    "autoRefreshInterval": 30,    // (seconds)
    "debugLogging":         true,
    "clearOnInit":          false,
    "version":              "1.0"
});
```

Warning: The `maxSize` property in `$A.storageService.initStorage()` has a unit of bytes. This is different than the `maxSize` attribute in `<auraStorage:init>`, which has a unit of KB.

Storage Versions

The storage service uses an optional version as part of the key when getting or setting items. This attribute enables you to cache data specific to different versions of your app. You can change the default version for an app. When you retrieve data from the cache using the new version, the cached data for the old version is ignored as it has a different key. This avoids the problem of clients retrieving data associated with an old version from the cache.

There are two types of versions for storage: an app-level default version and a version specific to an individual store. If you don't specify a version when you create storage, the storage inherits the app-level default.

Use `$A.storageService.setVersion()` to create an app-level version. Use the `version` parameter in `$A.storageService.initStorage()` or the `version` attribute in `<auraStorage:init>` to set a storage-specific version when you initialize the storage.

SEE ALSO:

Storable Actions

Using Storage Service

Using Storage Service

After you've initialized your custom storage, you can add and retrieve items from your storage. To do so, use the JavaScript `set` and `get` API of AuraStorage.

Storage Service uses ES6 Promises. For more information about promises, see https://developers.google.com/web/fundamentals/getting-started/primers/promises.

`AuraStorage` calls are asynchronous and return a `Promise` object that is resolved when the operation completes, or rejected if an error occurred.

Note: Promises execute their resolve and reject functions asynchronously so the code is outside the Aura event loop and normal rendering lifecycle. If the resolve or reject code makes any calls to Aura, such as setting a component attribute, use `$A.getCallback()` to wrap the code. For more information, see Modifying Components Outside the Framework Lifecycle on page 189.

The framework-provided actions storage for server-side actions automatically adds and retrieves items from storage and doesn't require you to call `set` and `get` explicitly. See Storable Actions on page 224.

Getting and Setting Items

This example shows how to use a storage object to explicitly store items. For information on initializing a storage object, see Initializing Storage Service on page 237.

The call to `set` takes a key that is used to uniquely identify the stored item, and returns a `Promise` that resolves when the operation is complete.

```
var value1 = 67;
// returns a Promise object that is not used here
storage.set("score", value1);
```

```
storage.set("name", "joe smith")
  .then(function() { console.log("name is stored"); },
        function(err) { console.log("named failed to store: " + err) }
  );
```

The first function in `then()` is called when the `Promise` resolves. The second function is called when the `Promise` rejects.

You can retrieve stored items by using the `get` method. The `get` method takes as a parameter the key of the object you wish to retrieve. It returns a `Promise` that resolves to the retrieved value or `undefined` if the key is not found.

```
storage.get("score")
  .then(function(value) { console.log("score is " + value); })
  .then(function() { return storage.get("name"); })
  .then(function(value) { console.log("name is " + value); },
        function(err) { console.log("failed: " + err); }
  );
```

Note: If you're getting or setting more than one value, use `getAll()` or `setAll()` for better performance.

Using Other `AuraStorage` Methods

You can obtain any initialized named storage by calling `getStorage()` and by passing it the storage name. For example:

```
var storage = $A.storageService.getStorage("MyStorage");
```

Note: The `getName()` method returns the type of storage selected, not the name of the storage.

There are other methods available in the JavaScript API. For example, you can get the current and max size:

```
var storage = $A.storageService.getStorage("MyStorage");
storage.getSize().then(
  function(size) { return size; },
  function(err) { return "unknown"; }
).then(function(size) {
  var max = storage.getMaxSize();
  console.log("size is " + size + " KB of max " + max + " KB");
});
```

To clear the storage:

```
var storage = $A.storageService.getStorage("MyStorage";
storage.clear().then(
  function() { console.log("storage has cleared"); },
  function(err) { console.log("storage failed to clear: " + err); }
);
```

SEE ALSO:

Storable Actions

Initializing Storage Service

CHAPTER 12 Testing and Debugging Components

In this chapter ...

Aura's loosely coupled components facilitate maintainability and enable efficient testing. Components are isolated from their application context for easier testing. Aura supports JavaScript testing for components and applications in production mode.

Add component tests to a JavaScript file in the component bundle. For example, a component `myData.cmp` in the `myApp` namespace is saved in the folder `myData`, which can contain a test file `myDataTest.js`.

To reuse code among test cases, use the `setUp` and `tearDown` functions, which can be useful for quickly setting up or removing objects. They are called before and after a test method is run. During test execution, additional suite methods can be accessed with `this.sharedMethod()`.

> **Note:** You can view Aura's test methods in the JavaScript API reference. Assertions and utility functions are also available for unit testing.

Run JavaScript tests in a Web browser by appending `?aura.mode=JSTEST` to your production component. For example, if you have a component `myData.cmp` in the `myApp` namespace, you can run test cases on `http://<your server>/myApp/myData.cmp?aura.mode=JSTEST`.

SEE ALSO:

Component Bundles

Modes Reference

Assertions

Utility Functions

JavaScript Test Suite Setup

A test file in a component bundle contains a suite of tests and properties, where each function represents a different test case.

You would typically define any shared properties before your test cases. Your test functions must follow the naming convention `test<testName>`. Prepending an underscore to the test function name like `_testGetResult` disables the test. A basic test suite looks like this.

```
({
   /** Properties shared across test cases**/
    attributes: {
        label: 'Submit',
        //Other attributes here
    },
    browsers: ['GOOGLECHROME', 'SAFARI', 'IPAD' ],
    setUp: function(component){
        //Runs before each test case is executed but after component initialization
    },
    tearDown: function(component){
        //Runs after each test case is executed
    },
    sharedMethod: function(arg1, arg2){
        //Utility functions that are invoked by calling this.sharedMethod(x, y)
    },

    /** Test Cases **/
    testCase1: {
        attributes: {
            //Attributes
        },
        //Runs all supported browsers except Firefox.
        //Overrides the suite level browsers tag.
        browsers: [ '-FIREFOX'],
        test: [ //A single function or a list of functions
               function(component){
                  //Test something
               },
               function(component){
                  //Test something
               }
               ]
    }
})
```

The `attributes` property specifies the attribute values that the component to be tested should be instantiated with. The `attributes` and `browsers` properties are optional.

Test Suite Properties

Test suite properties are values that the target component are instantiated with. The following lists supported properties for a test suite.

`attributes`

Applies to suite or test level. Setting attribute values outside of a test case applies the attribute values to the whole suite. If a test has both test level and suite level attributes, the test level attributes override those at the suite level.

Attribute values are passed as query parameters in the initial GET request. For example, this code initializes the `label` and `buttonTitle` attributes on a `ui:button` component.

```
attributes:{
    label: 'Submit',
    buttonTitle: 'click once'
}
```

auraWarningsExpectedDuringInit

Applies to test level only and accepts an array of Strings, where each String is an expected warning message. When the `failOnWarning` flag is set, `auraWarningsExpectedDuringInit` specify warnings from `$A.warning` allowed during initialization that won't fail the test. For more information, see Fail a Test Only When Expected on page 245.

browsers

Applies to suite or test level. List browsers you want all test cases to test against. If this property is not specified, the tests execute in all supported browsers. Values prefixed with a hyphen exclude that browser from the test.

```
browsers: [ 'GOOGLECHROME', 'SAFARI', '-IPAD' ]
```

By default, the tests run on desktop and mobile browsers. To test only for desktop or mobile browsers, specify the `DESKTOP` or `MOBILE` attribute.

```
browsers: [ 'DESKTOP'] // Run tests for desktop browsers only
```

If the `browsers` property is available in both the case level and the suite level, the case level property overrides the latter. Desktop browsers include `IE9`, `IE10`, `IE11`, `FIREFOX`, `GOOGLECHROME`, and `SAFARI`. Mobile browsers include `IPHONE`, `IPAD`, `ANDROID_PHONE`, `ANDROID_TABLET`.

doNotWrapInAuraRun

Applies to suite or test level. Each function block within a test is referred to as a stage. By default, each stage of the test executes within its own $A.run() function to ensure the test code goes through the full rendering lifecycle and that all enqueued actions are run before continuing on to the next stage or completing the test. If this is not the desired behavior for your tests, set `doNotWrapInAuraRun` to true.

failOnWarning

Applies to suite or test level. If true, the test will fail on any warnings received during test execution not marked as expected via a call to `$A.test.expectWarnings()`, or any warnings received during test setup not declared under the `auraWarningsExpectedDuringInit` tag. For more information, see Fail a Test Only When Expected on page 245.

setUp

This property executes before each test case but after the component has been initialized.

tearDown

This property executes after each test case, regardless of the test status.

sharedMethod

Put additional utility functions here if your test needs to access them. This example is invoked with `this.sharedMethod(x,y)`.

```
sharedMethod: function(argument1, argument2){
    $A.test.assertNotNull(argument1, 'The first argument received was null');
    }
```

sharedString

Share a string or function for multiple tests in the same test file.

```
sharedString: "My shared string",
sharedFunction: function(){},
```

```
testFunction:function(){
    this.sharedFunction(this.sharedString);
}
```

mocks

Mocking isolates your JavaScript tests from other resources, such as a Java model, provider, or server-side controller. Mocks that are defined as a suite property are shared among all test cases. For more information, see Mocking Java Classes on page 276.

Test Cases

Test cases are typically defined after the suite properties. They contain the `attributes`, `browsers`, and `mocks` properties. If these properties are specified in a test case, their values override those provided by suite properties. Additionally, a test case can contain a `test` property that's defined with a function or a list of functions. After the first function runs, the test waits for `$A.test.addWaitFor` to complete. This example method compares `expected` and the return value of the `lookForTextAfterClick`. When this comparison evaluates to true, the next function is run.

```
test: [
        function(component){
        $A.test.assertTrue(true, 'This obviously should have passed.');
        $A.test.assertEquals( 'Opt Out', component.get("v.label"), "Wrong label.");
        $A.test.assertEquals( 'click once', component.get("v.buttonTitle"), "Wrong
tooltip.");
        debugger;  // Break at this point in browsers that support the directive
        component.get('e.press').fire();
        $A.test.addWaitFor('expected', function(){
             var lookForTextAfterClick = component.get('v.updatedOnClick');
             return lookForTextAfterClick;
        });
    }, function(component){
       $A.test.assertTrue(true, 'This also obviously should have passed after the click.');
}]
```

To display an error message when the test function times out, use `$A.test.addWaitForWithFailureMessage`. This example runs a test that expects a result length of one by default, or two if the component is rendered on a phone.

```
test: function(cmp) {
    var expectedResultLength = 1;
    if ($A.get("$Browser.formFactor") == 'PHONE') {
        expectedResultLength = 2;
    }
    $A.test.addWaitForWithFailureMessage(
       expectedResultLength,
       function() {
           return result.length;
       },
       "Unexpected number of items in result");
}
```

IN THIS SECTION:

Pass a Controller Action in Component Tests

Invoke a controller action by wrapping it in a component.

[Fail a Test Only When Expected](#)
You can set a test to expect an error or warning, and fail a test only when you expect it to fail.

Pass a Controller Action in Component Tests

Invoke a controller action by wrapping it in a component.

You can't pass in a function or action as an attribute in component tests. Instead, use a component wrapper. For example, you want to pass an action in the following component to a test.

```
<!-- myNamespace:childCmp -->
<aura:component>
    <aura:attribute name="put" type="Aura.Action"/>
</aura:component>
```

Use a component wrapper that looks like this:

```
<aura:component>
    <aura:attribute name="items" type="integer" default="0"/>
    box called {!v.items} times
    <myNamespace:childCmp aura:id="putter" put="{!c.box}"/>
</aura:component>
```

The controller action retrieves the items attribute in the component and increments its value.

```
({
    box: function(cmp, event) {
        var items = cmp.get("v.items");
        cmp.set("v.items", items + 1);
    }
})
```

The following test verifies the type of action that's passed in the component. `auraType` checks if the object is of a certain type, for example, whether it's of type `Component`, `Action`, or `Event`.

```
testAction: {
    test: function(component){
        var box = component.get("c.box");
        $A.test.assertAuraType("Action", box, "The type was incorrect.");
        $A.test.assertEquals("function", typeof box.run, "The run was not a function on
the actions.");
    }
}
```

Note: The `auraType` attribute is deprecated. Use `$A.test.assertAuraType` to check if a value is an instance of the expected type.

Fail a Test Only When Expected

You can set a test to expect an error or warning, and fail a test only when you expect it to fail.

All tests will fail on errors by default. There is no tag/setting to make a test not fail on errors. You must mark each individual error as expected. All tests will pass on warnings by default. If `failOnWarning: true` is set, then the test will fail for any warnings not marked as expected.

To enable your test to expect an error or warning during initialization, use `auraErrorsExpectedDuringInit` or `auraWarningsExpectedDuringInit`. The test fails only if any of the expected errors don't happen. To enable your test to expect an error or warning during the test itself, use `$A.test.expectAuraError` or `$A.test.expectAuraWarning`.

```
({
    failOnWarning: true,

    /**
     * This case inherits the suite level failOnWarning so we need to declare
auraWarningsExpectedDuringInit to account
     * for warning in the controller's init function and have $A.test.expectAuraWarning
for any warnings in the test
     * block itself.
     */
    testExpectedWarning: {
        auraWarningsExpectedDuringInit: ["Expected warning from auraWarningTestController
 init"],
        test: function(cmp) {
            var warningMsg = "Expected warning from testExpectedWarning";
            var warningMsg2 = "Expected warning from testExpectedWarning2";
            $A.test.expectAuraWarning(warningMsg);
            $A.test.expectAuraWarning(warningMsg2);
            $A.warning(warningMsg);
            $A.warning(warningMsg2);
        }
    },

    /**
     * Override suite level failOnWarning and verify test does not fail on warnings.
     */
    testNoFailOnWarning: {
        failOnWarning: false,
        test: function(cmp) {
            $A.warning("Expected warning from testNoFailOnWarning");
        }
    }
})
```

Assertions

Assertions evaluate an object or expression for expected results and are the foundation of component testing. Each JavaScript test can contain one or more assertions. The test passes only when all the assertions are successful. Assertions should be prefixed with `$A.test`. If an assertion fails, an error message is typically returned with the `assertMessage` or `errorMessage` string.

Include unique and specific error messages in your assert statements. For example, use `assertTrue(run, "Returns true if the action has  run successfully.")` instead of a generic message. Making each assert message unique also helps in narrowing down which assert statement has failed.

Aura supports the following assertions.

`$A.test.assert()`

Asserts that the condition is `true`.

Syntax

```
$A.test.assert(condition:Object, assertMessage:String)
```

Arguments

Name	Type	Description
`condition`	Object	The condition to evaluate.
`assertMessage`	String	The message that is returned if the condition is not false.

`$A.test.assertAccessible()`

Asserts that the HTML output of the target component is accessibility compliant. Throws an error containing a concatenated string representation of all accessibility errors found.

Syntax

```
$A.test.assertAccessible()
```

`$A.test.assert()`

Asserts that the condition is `true`.

Syntax

```
$A.test.assert(condition:Object, assertMessage:String)
```

Arguments

Name	Type	Description
`condition`	Object	The condition to evaluate.
`assertMessage`	String	The message that is returned if the condition is not false.

`$A.test.assertAuraType()`

Asserts that the value is an instance of the expected type.

Syntax

```
$A.test.assertAuraType(type:String, condition:Object, assertMessage:String)
```

Arguments

Name	Type	Description
`type`	String	The type to evaluate. Valid types: • Action • ActionDef • Event • EventDef • Component • ComponentDef • ControllerDef • ModelDef • AuraError • PropertyReferenceValue
`condition`	Object	The argument to evaluate.
`assertMessage`	String	The message that is returned if the value is null.

$A.test.assertDefined()

Asserts that the value is not undefined.

Syntax

```
$A.test.assertDefined(condition:Object, assertMessage:String)
```

Arguments

Name	Type	Description
`condition`	Object	The condition to evaluate.
`assertMessage`	String	The message that is returned if the condition is not false.

$A.test.assertEquals()

Asserts that the values provided are equal. This function asserts that `arg1 === arg2` is `true`, where `arg1` is the expected value and `arg2` is the actual value.

Syntax

```
$A.test.assertEquals(arg1:Object, arg2:Object, assertMessage:String)
```

Arguments

Name	Type	Description
`arg1`	Object	The first argument to evaluate against.
`arg2`	Object	The second argument to evaluate against.

Name	Type	Description
`assertMessage`	String	The message that is returned if the two values are not equal.

`$A.test.assertEqualsIgnoreWhitespace()`

Asserts that the values provided are equal while ignoring whitespaces.

Syntax

```
$A.test.assertEqualsIgnoreWhitespace(arg1:Object, arg2:Object, assertMessage:String)
```

Arguments

Name	Type	Description
`arg1`	Object	The first argument to evaluate against.
`arg2`	Object	The second argument to evaluate against.
`assertMessage`	String	The message that is returned if the two values are not equal.

`$A.test.assertFalse()`

Asserts that the condition is `false`.

Syntax

```
$A.test.assertFalse(condition:Boolean, assertMessage:String)
```

Arguments

Name	Type	Description
`condition`	Boolean	The condition to evaluate.
`assertMessage`	String	The message that is returned if the condition is not false.

`$A.test.assertFalsy()`

Asserts that the condition is zero, an empty string, `false`, `null`, or `undefined`.

Syntax

```
$A.test.assertFalsy(condition:Boolean, assertMessage:String)
```

Arguments

Name	Type	Description
`condition`	Boolean	The condition to evaluate.
`assertMessage`	String	The message that is returned if the condition is not met.

$A.test.assertNotEquals()

Asserts that the values provided are not equal. This function asserts that `arg1 === arg2` is `false`, where `arg1` is the expected value and `arg2` is the actual value.

Syntax

```
$A.test.assertNotEquals(arg1:Object, arg2:Object, assertMessage:String)
```

Arguments

Name	Type	Description
`arg1`	Object	The first argument to evaluate against.
`arg2`	Object	The second argument to evaluate against.
`assertMessage`	String	The message that is returned if the two values are equal.

$A.test.assertNotNull()

Asserts that the value is not null.

Syntax

```
$A.test.assertNotNull(condition:Object, assertMessage:String)
```

Arguments

Name	Type	Description
`condition`	Object	The argument to evaluate.
`assertMessage`	String	The message that is returned if the value is null.

$A.test.assertNull()

Asserts that the value is null.

Syntax

```
$A.test.assertNull(condition:Object, assertMessage:String)
```

Arguments

Name	Type	Description
`condition`	Object	The argument to evaluate.
`assertMessage`	String	The message that is returned if the value is not null.

$A.test.assertNotUndefinedOrNull()

Asserts that the value is not undefined or null.

Syntax

```
$A.test.assertNotUndefinedOrNull(condition:Object, assertMessage:String)
```

Arguments

Name	Type	Description
`condition`	Object	The argument to evaluate.
`assertMessage`	String	The message that is returned if the value is undefined or null.

`$A.test.assertUndefined()`

Asserts that the value is undefined.

Syntax

```
$A.test.assertUndefined(condition:Object, assertMessage:String)
```

Arguments

Name	Type	Description
`condition`	Object	The argument to evaluate.
`assertMessage`	String	The message that is returned if the value is not undefined.

`$A.test.assertUndefinedOrNull()`

Asserts that the value is undefined or null.

Syntax

```
$A.test.assertUndefinedOrNull(condition:Object, assertMessage:String)
```

Arguments

Name	Type	Description
`condition`	Object	The argument to evaluate.
`assertMessage`	String	The message that is returned if the value is not undefined or null.

`$A.test.assertStartWith()`

Asserts that a string starts with another.

Syntax

```
$A.test.assertStartWith(start:Object, full:Object, assertMessage:String)
```

Arguments

Name	Type	Description
`start`	Object	The start string.
`full`	Object	The full string that is expected to begin with the start string.
`assertMessage`	String	The message that is returned if the full string does not begin with the start string.

`$A.test.assertTrue()`

Asserts that the condition is true.

Syntax

```
$A.test.assertTrue(condition:Object, assertMessage:String)
```

Arguments

Name	Type	Description
`condition`	Object	The argument to evaluate.
`assertMessage`	String	The message that is returned if the condition is not true.

`$A.test.assertTruthy()`

Asserts that the condition is an object, a string, a non-zero number, a non-empty array, or true.

Syntax

```
$A.test.assertTrue(condition:Object, assertMessage:String)
```

Arguments

Name	Type	Description
`condition`	Object	The argument to evaluate.
`assertMessage`	String	The message that is returned if the condition is not met.

`$A.test.fail()`

Throws an error with the specified message, making a test fail. For example:

```
try {
    // do something where you expect an error
    $A.test.fail("should have got an error");
}
catch(e){
    // assert expected error
}
```

Syntax

```
$A.test.fail(assertMessage:String, extraInfoMessage:String)
```

Arguments

Name	Type	Description
assertMessage	String	The message to return when the test fails. If not provided, the message defaults to "Assertion failure".
extraInfoMessage	String	Additional information about the test failure.

SEE ALSO:

Supporting Accessibility

Debugging Components

Use the `debugger;` statement to debug your JavaScript tests, with the debug console in your browser opened. Remove or comment out the `debugger;` statement after you finish debugging.

You can view your debug output by appending `?aura.mode=JSTESTDEBUG` to your production component, which has minimal formatting for readability. Otherwise, append `?aura.mode=JSTEST` for a minified debug output.

Another useful tool for debugging is Google Chrome's Developer Tools.

- To open Developer Tools on Windows and Linux, press Control - Shift - I in your Chrome browser.
- To quickly find which line of code a test fails on, enable the **Pause on all exceptions** option before running the test.

To simulate a user interaction in a test case, fire the associated Aura event. For example, use `buttonComponent.get("e.press").fire()` to simulate a button click event. To fire this event in the browser console, use `$A.getRoot().find("buttonId").get("e.press").fire()`. `$A.getRoot()` returns a reference to the top level component. `buttonId` refers to the local ID of the button component.

SEE ALSO:

Debugging

Communicating with Events

Modes Reference

Utility Functions

Utility functions provide additional support for component unit tests and are prefixed with `$A.test`.

Aura provides the following utility functions.

`$A.test.addEventHandler()`

Adds an event handler. If component is specified, the handler is applied to component events. If component is not specified, the handler will be applied to application events.

Syntax

```
$A.test.addEventHandler(eventName:String, handler:Function, component:Component,
insert:Boolean)
```

Arguments

Name	Type	Description
`eventName`	String	The registered name, for component events; the descriptor name for application events.
`handler`	Function	The function handler, which should expect the event as input.
`component`	Component	The component to add the handler on.
`insert`	Boolean	Set to true to insert the handler at the front of the list for component events only. Otherwise, the handler is inserted at the end.

$A.test.addFunctionHandler

Adds a function handler and overrides the original function. The handler may be attached before or after the target function. If attached after (postProcess === true), the handler will be invoked with the original function's return value followed by the original arguments. If attached before (postProcess !== true), the handler will be invoked with just the original arguments.

Syntax

```
$A.test.addFunctionHandler(instance:Object, name:String, newFunction:Function,
postProcess:Boolean)
```

Arguments

Name	Type	Description
`instance`	Object	The instance of the object.
`name`	String	The name of the function whose arguments are applied to the handler.
`newFunction`	Function	The target function to attach the handler to.
`postProcess`	Boolean	Set to true if the handler is called after the target function or false if the handler is called before the original function.

Response

The response is a function that overrides the original function. The function has a `restore` function that can be used to restore the original function.

$A.test.addPrePostSendCallback

Inserts a callback either before or after sending of XHR. One of `preSendCallback` or `postSendCallback` can be null, but not both.

Syntax

```
$A.test.addPrePostSendCallback(action:Action, preSendCallback:Function,
postSendCallback:Function)
```

Arguments

Name	Type	Description
`action`	Object	The action to watch for.
`preSendCallback`	Function	The function to call before sending of XHR.
`postSendCallback`	Function	The function to call after sending of XHR.

Response

The response is a `prePostConfig` object to remove the callback later (needed only if the `action` parameter is empty).

`$A.test.addPostSendCallback()`

Inserts a callback after sending of XHR. For the post XHR callback, the XHR has not been sent, but actions are serialized and put in the actual request.

Syntax

```
$A.test.addPostSendCallback(action:Action, postSendCallback:Function)
```

Arguments

Name	Type	Description
`action`	Object	The action to watch for.
`postSendCallback`	Function	The function to call after sending of XHR.

Response

The response is a handle to remove the callback (only needed if the `action` parameter is empty).

`$A.test.addPreSendCallback()`

Inserts a callback before sending of XHR.

Syntax

```
$A.test.addPreSendCallback(action:Action, preSendCallback:Function)
```

Arguments

Name	Type	Description
`action`	Object	The action to watch for.

Name	Type	Description
`preSendCallback`	Function	The function to call before sending of XHR.

Response

The response is a handle to remove the callback (only needed if the `action` parameter is empty).

`$A.test.addWaitFor`

Asynchronously waits for a condition (`expected === testFunction()`) before continuing with the next stage of the test case. The wait condition is checked after the current test stage is completed but before the next stage is started..

Syntax

```
$A.test.addWaitFor(expected:Object, testFunction:Object, callback:Function)
```

Arguments

Name	Type	Description
`expected`	Object	The value to compare against. If this is a function, it's evaluated before comparison.
`testFunction`	Object	A function to evaluate and compare against `expected`.
`callback`	Function	Invoked after the comparison evaluates to true.

`$A.test.addWaitForWithFailureMessage`

Asynchronously waits for a condition before continuing with the next stage of the test case. The wait condition is checked after the current test stage is completed but before the next stage is started.

Syntax

```
$A.test.addWaitForWithFailureMessage(expected:Object, testFunction:Object,
failureMessage:String, callback:Function)
```

Arguments

Name	Type	Description
`expected`	Object	The value to compare against. If this is a function, it's evaluated before comparison.
`testFunction`	Object	A function to evaluate and compare against `expected`.
`failureMessage`	String	The message that is returned if the condition is not true.
`callback`	Function	Invoked after the comparison evaluates to true.

`$A.test.addCleanup()`

Add a cleanup function that is run on teardown.

Syntax

```
$A.test.addCleanup(cleanupFunction:Function)
```

Arguments

Name	Type	Description
`cleanupFunction`	Function	The function to run on teardown.

`$A.test.areActionsComplete()`

Checks to see if an array of actions have all completed.

Syntax

```
$A.test.areActionsComplete()
```

Response

Returns *`true`* if the action state is no longer `NEW` or `RUNNING`.

`$A.test.blockRequests()`

Blocks requests (actions) from being sent to the server. This function is used to artificially force actions to be held on the client to be sent to the server at a later time. It can be used to simulate delays in processing or rapid action queueing on the client.

Syntax

```
$A.test.blockRequests()
```

`$A.test.blockForegroundRequests()`

Blocks only foreground actions from being sent to the server.

Syntax

```
$A.test.blockForegroundRequests()
```

`$A.test.blockBackgroundRequests()`

Blocks only background actions from being sent to the server.

Syntax

```
$A.test.blockForegroundRequests()
```

`$A.test.callServerAction`

Runs a server action. The test waits for any actions to complete before running the next function. If `doImmediate` is set to true, the request is sent immediately. Otherwise, the action is queued after prior requests.

Syntax

```
$A.test.callServerAction(action:Action, doImmediate:Boolean)
```

Arguments

Name	Type	Description
action	Action	The action to run
doImmediate	Boolean	Set to true to send the request immediately, otherwise the action will be handled as any other action and may be queued behind prior requests.

$A.test.clearAndAssertComponentConfigs()

Clears out component configurations returned by an action. Call this function within the action callback.

Syntax

```
$A.test.clearAndAssertComponentConfigs(action:Action)
```

Arguments

Name	Type	Description
action	Action	The action to clear.

$A.test.clickOrTouch()

Fires a click event on the element.

Syntax

```
$A.test.clickOrTouch(element:HTMLElement, canBubble:Boolean, cancelable:Boolean)
```

Arguments

Name	Type	Description
element	HTMLElement	The element to click on.
canBubble	Boolean	The string to look for within the other string.
cancelable	Boolean	Indicates whether the event is cancelable or not.

$A.test.contains()

Checks if a string contains another string.

Syntax

```
$A.test.contains(testString:String, targetString:String)
```

Arguments

Name	Type	Description
`testString`	String	The string to check
`targetString`	String	The string to look for within the other string.

Response

Returns *true* if `testString` contains `targetString`, or *false* otherwise.

$A.test.compareValues()

Compares the source and target values. For an Array or Object, this function compares first level references only. For literals, this function compares value and type equality directly.

Syntax

```
$A.test.compareValues(expected:Object, actual:Object)
```

Arguments

Name	Type	Description
`expected`	Object	The source value to compare.
`actual`	Object	The target value to compare.

Response

Returns an Object that denotes the result of the comparison, with reasons.

$A.test.getGlobalValueProvider()

Returns the global value providers based on type.

Syntax

```
$A.test.getGlobalValueProvider(type:String)
```

Arguments

Name	Type	Description
`type`	String	The type of global value providers.

$A.test.decode()

Creates a passthrough to the JSON decode utility for tests. This function decodes a JSON string into an object.

Syntax

```
$A.test.decode(obj:Object, refSupport:Object)
```

Arguments

Name	Type	Description
`obj`	Object	The object to be decoded.
`refSupport`	Object	Optional. Resolves duplicate object references.

`$A.test.enqueueAction()`

Enqueues an action in an Aura call.

Syntax

```
$A.test.enqueueAction(action:Object, background:Boolean)
```

Arguments

Name	Type	Description
`action`	Object	The action to enqueue.
`background`	Boolean	Set to true to run the action in the background. The default value is evaluated by `action.isBackground()`.

`$A.test.executeAfterCkEditorIsReady()`

Waits for CKEditor instance in the `ui:inputRichText` component to be ready before continuing to enter test data.

Syntax

```
$A.test.executeAfterCkEditorIsReady(component:Component, callback:Function)
```

Arguments

Name	Type	Description
`component`	Component	The `ui:inputRichText` component, or a component that extends it.
`callback`	Function	Invoked after the CKEditor is ready for data to be set.

Response

Returns an Object that denotes the result of the comparison, with reasons.

`$A.test.expectAuraWarning()`

Tells the test that a warning is expected. The test fails when it does not receive the expected warning.

Syntax

```
$A.test.enqueueAction(msg:String)
```

Arguments

Name	Type	Description
`w`	String	The warning message to expect.

$A.test.findChildWithClassName()

Returns the first element on the page starting from the parent element with the specified class name.

Syntax

```
$A.test.findChildWithClassName(parentElement:DOMElement, className:String)
```

Arguments

Name	Type	Description
`parentElement`	DOMElement	The DOM element to start at.
`className`	String	The CSS class name.

$A.test.fireDomEvent()

Fires the DOM event for a given HTML element and event name.

Syntax

```
$A.test.fireDomEvent(element:Object, eventName:String, canBubble:Boolean,
cancelable:Boolean)
```

Arguments

Name	Type	Description
`element`	Object	The HTML element whose corresponding DOM event is to be fired.
`eventName`	String	Initializes the given event that bubbles up through the event chain.
`canBubble`	Boolean	Optional. Indicates whether the event can be bubbled. Defaults to true.
`cancelable`	Boolean	Optional. Indicates whether the event is cancelable or not. Defaults to true.

$A.test.getAction()

Returns an instance of an action based on the specified parameters and callback function.

Syntax

```
$A.test.getAction(component:Component, name:String, params:Object, callback:Function)
```

Arguments

Name	Type	Description
`component`	Component	The component on which the action is available.

Name	Type	Description
`name`	String	The name of the action.
`params`	Object	The parameters to pass to the action.
`callback`	Function	The callback function to execute for the action, or if not a function, a name for the action.

`$A.test.getActiveElement()`

Returns the DOMElement of the object that is currently designated as the active element.

Syntax

```
$A.test.getActiveElement()
```

`$A.test.getActiveElementText()`

Returns the inner text of the current active DOM element.

Syntax

```
$A.test.getActiveElementText()
```

`$A.test.getAllComponentDefsFromStorage()`

Returns all definitions from `ComponentDefStorage`.

Syntax

```
$A.test.getAllComponentDefsFromStorage()
```

`$A.test.getCreationPath()`

Returns the creation path, for example, `/*[0]` for the root component and `/*[0]/$/*[0]` if the body of the component appears first in the super component.

Syntax

```
$A.test.getCreationPath(cmp:Component)
```

Arguments

Name	Type	Description
`cmp`	Component	The component to evaluate.

`$A.test.getElementByClass()`

Returns the first element on the page that has the specified class name.

Syntax

```
$A.test.getElementByClass(classname:String)
```

Arguments

Name	Type	Description
`className`	String	The CSS class name.

`$A.test.getErrors()`

Returns errors as JSON encoded strings. If no errors are found, return an empty string.

`$A.test.getExternalAction`

Returns an instance of a server action that's unavailable to the component.

Syntax

```
$A.test.getExternalAction(component:Component, descriptor:String, params:Object,
returnType:Object, callback:Function)
```

Arguments

Name	Type	Description
`component`	Component	The component to run the action with, even if the action is not available to it.
`descriptor`	String	The descriptor for the action, for example, `java://my.own.Controller/ACTION$doIt`
`params`	Object	The parameters to pass to the action.
`returnType`	Object	The return type descriptor for the action, for example, `java://java.lang.String`
`callback`	Function	An optional callback to execute with the component

`$A.test.getOuterHtml(node)`

Returns the outer HTML of an element.

`$A.test.getPrototype()`

Returns the prototype of the instance or object.

Syntax

```
$A.test.getPrototype(instance:Object)
```

Arguments

Name	Type	Description
`instance`	Object	The instance of the object

`$A.test.getAction(component, name, params, callback)`

Returns an instance of an action.

`$A.test.getElementAttributeValue()`

Returns attribute value of an element.

Syntax

```
$A.test.getElementAttributeValue(element:HTMLElement, attributeName:String)
```

Arguments

Name	Type	Description
`element`	HTMLElement	The element from which to retrieve data.
`attributeName`	String	The name of attribute to look up on element.

`$A.test.getErrors()`

Returns the list of errors for the test, not including any errors handled explicitly by the framework.

Syntax

```
$A.test.getErrors()
```

Response

Returns an empty string if there are no errors, or a JSON encoded list of errors.

`$A.test.getOuterHtml()`

Returns a DOM node's outer HTML markup.

Syntax

```
$A.test.getOuterHtml(node:Node)
```

Arguments

Name	Type	Description
`node`	Node	The node from which to get the outer HTML

$A.test.getNonCommentNodes()

Filters out comment nodes from a list of nodes.

Syntax

```
$A.test.getNonCommentNodes(nodes:Array|Object)
```

Arguments

Name	Type	Description
`nodes`	Array|Object	The list of nodes to filter

$A.test.getSentRequestCount()

Returns total count of foreground and background requests sent to the server. This function can be used to get a before and after count on server requests to verify that only the necessary requests are being sent.

Syntax

```
$A.test.getSentRequestCount()
```

$A.test.getStyle()

Returns the CSS property value for a style for the specified DOMElement.

Syntax

```
$A.test.getStyle(elem:DOMElement, style:String)
```

Arguments

Name	Type	Description
`elem`	DOMElement	The node from which to get the text content.
`style`	String	The property name to retrieve.

$A.test.getTestName()

Returns the test name.

Syntax

```
$A.test.getTestName()
```

$A.test.getText()

Returns text content of a DOM node. Tries `textContent`, followed by `innerText` and `nodeValue` to consider browser differences.

Syntax

```
$A.test.getText(node:Node)
```

Arguments

Name	Type	Description
node	Node	The node from which to get the text content.

$A.test.getTextByComponent()

Returns text content rendered by a component.

Syntax

```
$A.test.getTextByComponent(component:Component)
```

Arguments

Name	Type	Description
component	Component	The component from which to get the text content.

$A.test.isActionPending()

Checks if there are pending server actions.

Syntax

```
$A.test.isActionPending()
```

Response

Returns `true` if there are pending server actions, or `false` otherwise.

$A.test.isActionQueued()

Checks if there are queued server actions.

Syntax

```
$A.test.isActionQueued()
```

Response

Returns `true` if there are queued server actions, or `false` otherwise.

$A.test.isComplete()

Checks if the test has finished running.

Syntax

```
$A.test.isComplete()
```

Response

Returns `true` if the test has completed, or `false` otherwise.

`$A.test.isInstanceOf()`

Checks if an element is an instance of another element.

Syntax

```
$A.test.isInstanceOf(element:HTMLElement, elementType:HTMLElement, tag:String)
```

Arguments

Name	Type	Description
`element`	HTMLElement	The element to check.
`elementType`	HTMLElement	Checks `element` against `elementType`.
`tag`	String	Checks `element.tagName` against tag.

Response

Returns `true` if the element is of type `elementType`. If `elementType` is undefined, check element is of type ELEMENT_NODE and its `tagName` is equal to `tag`.

`$A.test.isInstanceOfAnchorElement()`

Checks if an element is an anchor element.

Syntax

```
$A.test.isInstanceOfAnchorElement(element:HTMLElement)
```

Arguments

Name	Type	Description
`element`	HTMLElement	The element to check

Response

Returns `true` if the element is an anchor element, or `false` otherwise.

`$A.test.isInstanceOfButtonElement()`

Checks if an element is a button element.

Syntax

```
$A.test.isInstanceOfButtonElement(element:HTMLElement)
```

Arguments

Name	Type	Description
`element`	HTMLElement	The element to check

Response

Returns *`true`* if the element is a button element, or *`false`* otherwise.

$A.test.isInstanceOfDivElement()

Checks if an element is a div element.

Syntax

```
$A.test.isInstanceOfDivElement(element:HTMLElement)
```

Arguments

Name	Type	Description
`element`	HTMLElement	The element to check

Response

Returns *`true`* if the element is a div element, or *`false`* otherwise.

$A.test.isInstanceOfImageElement()

Checks if an element is an image element.

Syntax

```
$A.test.isInstanceOfImageElement(element:HTMLElement)
```

Arguments

Name	Type	Description
`element`	HTMLElement	The element to check

Response

Returns *`true`* if the element is an image element, or *`false`* otherwise.

$A.test.isInstanceOfInputElement()

Checks if an element is an input element.

Syntax

```
$A.test.isInstanceOfInputElement(element:HTMLElement)
```

Arguments

Name	Type	Description
`element`	HTMLElement	The element to check

Response

Returns *`true`* if the element is an input element, or *`false`* otherwise.

`$A.test.isInstanceOfLiElement()`

Checks if an element is a list element.

Syntax

```
$A.test.isInstanceOfLiElement(element:HTMLElement)
```

Arguments

Name	Type	Description
`element`	HTMLElement	The element to check

Response

Returns *`true`* if the element is a list element, or *`false`* otherwise.

`$A.test.isInstanceOfParagraphElement()`

Checks if an element is a paragraph element.

Syntax

```
$A.test.isInstanceOfParagraphElement(element:HTMLElement)
```

Arguments

Name	Type	Description
`element`	HTMLElement	The element to check

Response

Returns *`true`* if the element is a paragraph element, or *`false`* otherwise.

`$A.test.isInstanceOfSpanElement()`

Checks if an element is a span element.

Syntax

```
$A.test.isInstanceOfSpanElement(element:HTMLElement)
```

Arguments

Name	Type	Description
element	HTMLElement	The element to check

Response

Returns `true` if the element is a span element, or `false` otherwise.

`$A.test.isInstanceOfText()`

Checks if a node is a text node.

Syntax

```
$A.test.isInstanceOfText(node:Node)
```

Arguments

Name	Type	Description
node	Node	The node to check

Response

Returns `true` if the node is a text node, or `false` otherwise.

`$A.test.isNodeDeleted()`

Checks if a node has been deleted by the framework.

Syntax

```
$A.test.isNodeDeleted(node:Node)
```

Arguments

Name	Type	Description
node	Node	The node to check

Response

Returns `true` if the node has been deleted, or `false` otherwise.

$A.test.orderedEncode()

Serializes object in alphabetical ascending order. Sorts object keys during serialization.

Syntax

```
$A.test.orderedEncode(obj:Object)
```

Arguments

Name	Type	Description
obj	Object	The object to serialize.

Response

Returns a string of serialized order object.

$A.test.overrideFunction()

Replaces a function on an object with a restorable override.

Syntax

```
$A.test.overrideFunction(instance:Object, name:String, newFunction:Function)
```

Arguments

Name	Type	Description
instance	Object	The instance of the object.
name	String	The name of the function to be replaced.
newFunction	String	The new function that replaces the original function.

Response

The response is a function that overrides the original function. The function has a `restore` function that can be used to restore the original function.

$A.test.releaseRequests()

Releases requests (actions) to be sent to the server. Call this function after `$A.test.blockRequests()` only. You can't release requests that are not blocked.

Syntax

```
$A.test.releaseRequests()
```

$A.test.releaseForegroundRequests()

Releases only foreground requests from being sent to the server. Call this function after `$A.test.blockRequests()` only. You can't release requests that are not blocked.

Syntax

```
$A.test.releaseForegroundRequests()
```

$A.test.releaseBackgroundRequests()

Releases only background requests from being sent to the server. Call this function after `$A.test.blockRequests()` only. You can't release requests that are not blocked.

Syntax

```
$A.test.releaseForegroundRequests()
```

$A.test.run()

Runs the test.

Syntax

```
$A.test.run(name:String, code:String, timeoutOverride:Integer)
```

Arguments

Name	Type	Description
`name`	String	A list of actions to run.
`code`	String	The scope for the callback
`timeoutOverride`	Integer	Optional. Increases the test timeout in seconds. The default is 10 seconds.

$A.test.runActionAsTransaction()

Runs a set of actions as a transaction. This function wraps around `$A.test.runActions()` to allow a test to safely run a set of actions as a single transaction with a callback.

Syntax

```
$A.test.runActionAsTransaction(actions:Array, scope:Object, callback:Function)
```

Arguments

Name	Type	Description
`actions`	Array	A list of actions to run.
`scope`	Object	The scope for the callback
`callback`	Function	The callback function to execute for the action

`$A.test.runAfterIf`

Runs a callback after `conditionFunction` evaluates to truthy, checking the condition at the specified interval. Truthy values can refer to a non-empty string, a non-zero number, a non-empty array, an object, or an expression evaluating to true.

Syntax

```
$A.test.runAfterIf(conditionFunction:Function, callback:Function, intervalInMs:Number)
```

Arguments

Name	Type	Description
`conditionFunction`	Function	The function to evaluate.
`callback`	Function	The callback function to run if the condition evaluates to truthy
`intervalInMs`	Number	The number of milliseconds between each evaluation of the condition. The default is 500 milliseconds.

`$A.test.select()`

Returns a list of nodes and passes each argument as a separate parameter.

Syntax

```
$A.test.select()
```

`$A.test.setTestTimeout()`

Sets the timeout in a period of milliseconds from now, clearing the existing timeout.

Syntax

```
$A.test.setTestTimeout(timeoutMs:Number)
```

Arguments

Name	Type	Description
`timeoutMs`	Number	The number of milliseconds from now in which the test should timeout.

`$A.test.storageAdapterSetItems()`

Stores items to storage through the storage's adapter, bypassing the key prefix and size validation logic AuraStorage performs.

Syntax

```
$A.test.storageAdapterSetItems(adapter:StorageAdapter, tuples:Array)
```

Arguments

Name	Type	Description
adapter	StorageAdapter	The storage adapter on which to store the items
tuples	Array	An array of key-value-size pairs

SEE ALSO:

Assertions

Sample Test Cases

Testing Label Values

This component contains two link buttons that save or cancel an action.

```
<!-- Component markup -->
<ui:outputURL label="Cancel" value="#" class="secondary-button" linkClick="{!c.onCancel}"/>
<ui:outputURL label="Save" value="#" class="primary-button" linkClick="{!c.onSave}"/>
```

The following test case uses assert statements to check that labels on the link buttons are set correctly. If you're using the global value provider `$Label` to set the label value in the component, use `$A.get("$Label.myLabel")` to retrieve the label.

```
({
browsers: ["-IE7", "-IE8"], //optional browser exclusion
testButtons : {
    test : [
        function testCancelButton(cmp) {
            $A.test.assertEquals(1, $A.test.select('.secondary-button').length,
                    'Cancel button is not being displayed.');

            $A.test.assertEquals("Cancel",
$A.test.getText($A.test.select('.secondary-button')[0]),
                    'Cancel button label is not set correctly.');
},

        function testSaveButton(cmp) {
            $A.test.assertEquals(1, $A.test.select('.primary-button').length,
                    'Save button is not being displayed.');

            $A.test.assertEquals("Save",
$A.test.getText($A.test.select('.primary-button')[0]),
                   'Save button label is not set correctly.');
        }
    ]
}
})
```

Testing Attribute Values

This component contains an input text area component with an attribute that sets the maximum number of characters.

```
<aura:attribute name="maxLength" type="Integer" default="5000"
                description="Max number of chars that can be inserted"/>
<ui:inputTextArea aura:id="textarea" label="My input"/>
```

The following test case checks that the attribute `maxLength` is correctly set.

```
{(
    testMaxLength:{
        attributes : { maxLength: 10 },
        test : function(cmp){
            cmp.set("v.value", "1234567890");
            cmp.getDef().getHelper().onValueChange(cmp);
            $A.test.assertEquals(0, this.getErrorCount(cmp), "No errors found");

            cmp.set("v.value", "12345678901");
            cmp.getDef().getHelper().onValueChange(cmp);
            $A.test.assertEquals(1, this.getErrorCount(cmp), "Too many characters");
    }
}
})
```

Testing HTML Elements

This component contains a `div` tag with a `class` attribute that is set on rendering.

```
<!-- Component Markup -->
<aura:attribute name="class" type="String" default="" description="Additional css classes"/>
<div aura:id="myCmp" class="{! 'myClass ' + v.class}">
    <!-- Other component markup -->
</div>
```

The following test case checks that the specified class is set on initial render and rerender.

```
({
    verifyMyCmp: function(cmp) {
        var ele = cmp.find("myCmp").getElement();
       $A.test.assertTrue($A.util.hasClass(ele, "myClass"), "Element is not rendered with
 myClass");

        // additional class
        if(cmp.get("v.class")) {
          $A.test.assertTrue($A.util.hasClass(ele, cmp.get("v.class")), "Additional class
 not added as expected");
        }
        else {
           $A.test.assertTrue($A.util.hasClass(ele, "testClass"), "Additional class added
 unexpectedly");
        }
    },
    testMyCmp: {
        attributes: {
```

```
            isVisible: true, //myCmp is rendered
            'class': "testClass",
        },
        test: function(cmp) {
            this.verifyMyCmp(cmp);
        }
    }
})
```

SEE ALSO:

JavaScript Test Suite Setup

Mocking Java Classes

Use mocking to isolate your JavaScript test from other resources, such as a Java model, provider, or server-side controller. This enables you to narrow the focus of the test and eliminate other modes of failure, such as network errors. You should test the external resources in separate tests.

Aura enables you to mock a Java model, provider, or server-side controller by using a `mocks` element in your test function. `mocks` is an array of objects representing the resource that you're mocking.

Let's look at the high-level structure of a test using a mocked object. `mocks` contains `type`, `stubs`, and `descriptor` elements.

```
testSampleSyntax : {
    mocks : [{
        type : "MODEL|PROVIDER|ACTION",
        // descriptor is optional
        descriptor : ...,
        stubs : [{
            // method is optional for a model or provider
            method : { ... },
            answers : [{
                // specify value or error but not both
                value : ...
                error : ...
            }]
        }]
    }],
    test : function(cmp) {
        // test code goes here
    }
},
```

type

The type of mock object. Valid values are: `MODEL`, `PROVIDER`, and `ACTION`.

stubs

An array of objects representing the Java methods of the class being mocked. A stub object has `method` and `answers` properties.

`method`

The `method` property is optional, except for the `ACTION` type. It defaults to `provide` for a provider, and `newInstance` for a model.

A `method` has the following elements:

- `name` is the method name.
- `params` is an array of Strings representing the input parameter types, if there are parameters.
- `type` is the return type. The default value is `Object`.

For example, this `method` element mocks `String doSomeWork(Boolean immediate, MyCustomType toProcess)`.

```
method : {
    name : "doSomeWork",
    type : "java.lang.String",
    params : ["java.lang.Boolean","my.package.MyCustomType"]
}
```

`answers`

The `answers` property is an array of answer objects returned by the stub when it is invoked.

An answer object has either a `value` or an `error` property. This indicates whether the mock returns the given value or throws a Java exception.

The format of the `value` object depends on the class being mocked. Provider values correspond to the `ComponentConfig` object returned by `provide()`, and can specify either `descriptor` or `attributes` or both.

Note: The framework doesn't support custom values, such as types that require a custom converter.

Multiple answers enable you to test sequencing or multiple invocations of an action. For example, if a test simulates clicking a button twice, this would call a server action twice, and you may want the actions to return different responses.

Alternatively, your component might load two or more input fields and you want the model to return different values for each field. If the mock is invoked more times than you have answers for, the last answer is repeated. For example, if the mock for an input field value returns the answers "anybody" and "there", but the component has four input fields, the mock returns "anybody", "there", "there", "there".

The `error` property is a `String` containing the fully qualified class name of the exception thrown. You can only use exceptions with no-argument constructors, or a constructor accepting a `String`.

`descriptor`

The `descriptor` element is optional and defaults to the descriptor for the resource being mocked. For example, this is the descriptor for a model class.

```
descriptor : "java://org.auraframework.docsample.SampleJavaModel",
```

To mock the type of a super or child component, such as a child `ui:input` component, you need to specify a `descriptor`.

Note: The descriptor for the `ACTION` type is the controller descriptor rather than the action descriptor. For example:

```
descriptor : "java://org.auraframework.docsample.SampleJavaController",
```

IN THIS SECTION:

Mocking Java Models

Mocking Java Providers

Mocking Java Actions

Mocking Java Models

This test mocks a Java model. The test function is a placeholder. You would add actual test code here.

```
testModelProperties : {
    mocks : [{
        type : "MODEL",
        stubs : [{
            answers : [{
                value : {
                    secret : { value : "<not available>" } ,
                    integer : { value : 1 },
                    stringList : { value : [ "early", "on", "time", "late"] }
                }
            }]
        }]
    }],
    test : function(cmp) {
        // test code goes here
    }
},
```

This test has a mock object that throws an exception.

```
testModelThrowsException : {
    mocks : [{
        type : "MODEL",
        stubs : [{
            answers : [{
                error : "org.auraframework.throwable.AuraRuntimeException"
            }]
        }]
    }],
    test : function(cmp) {
        // test code goes here
    }
},
```

SEE ALSO:

Java Models

Mocking Java Providers

Mocking Java Actions

Mocking Java Classes

Mocking Java Providers

This test mocks a Java provider. The test function is a placeholder. You would add actual test code here.

```
testProviderDescriptorAndAttributes : {
    mocks : [{
        type : "PROVIDER",
        stubs : [{
            answers : [{
                value : {
                    descriptor : "aura:text",
                    attributes : { value : "fresh"}
                }
            }]
        }]
    }],
    test : function(cmp) {
        // test code goes here
    }
},
```

The value element for a provider corresponds to the `ComponentConfig` object returned by `provide()`, and can specify either `descriptor` or `attributes` or both.

SEE ALSO:

- Server-Side Runtime Binding of Components
- Mocking Java Models
- Mocking Java Actions
- Mocking Java Classes

Mocking Java Actions

This test mocks an action in a Java server-side controller. The test function is a placeholder. You would add actual test code here.

```
testActionString : {
    mocks : [{
        type : "ACTION",
        stubs : [{
            method : { name : "getString" },
            answers : [{
                value : "what I expected"
            }]
        }]
    }],
    test : function(cmp) {
        // test code goes here
    }
},
```

This test has a mock object that throws an exception.

```
testModelThrowsException : {
    mocks : [{
```

```
        type : "ACTION",
        stubs : [{
            method : { name : "getString" },
            answers : [{
                error : "java.lang.IllegalStateException"
            }]
        }]
    }],
    test : function(cmp) {
        // test code goes here
    }
}
```

SEE ALSO:

Creating Server-Side Logic with Controllers

Mocking Java Models

Mocking Java Providers

CHAPTER 13 Customizing Behavior with Modes

In this chapter ...

Modes are used to customize Aura framework behavior. For example, the framework is optimized for performance in `PROD` (production) mode, and ease of debugging in `DEV` (development) mode.

Modes Reference

Aura supports different modes, which are useful depending on whether you are developing, testing, or running code in production. The list of modes in Aura is defined in the `AuraContext` Java interface.

Every request in Aura is associated with a context. After initial loading of an app, each subsequent request is an XHR POST that contains your Aura context configuration, which includes the mode to run in, and the name of the app.

We split the list of modes into two sections here to differentiate between runtime and test modes. This split is purely to cluster similar modes together in the documentation. All the runtime and core modes are defined in the `Mode` enum in `AuraContext`.

All modes are available by default in your app. Many of the modes use the Google Closure Compiler, which is a tool for optimizing JavaScript code.

Runtime Modes

Use these modes for running in development or production.

Mode	`PROD`	`DEV`	`PRODDEBUG`
Usage	Use for apps in production. The framework is optimized for performance rather than ease of debugging in this mode.	Use for apps in development. The framework is configured for ease of debugging in this mode.	Use temporarily to debug apps in production.
Debugging	Not recommended for debugging. Since `PROD` mode is intended for apps in production, test modes, such as `SELENIUM`, are preferable for running tests, especially concurrent tests.	Facilitates debugging. Pretty prints JSON responses from the server. Exposes private members in some framework JavaScript objects.	Facilitates debugging. JavaScript is non-minified and readable.
Access	Disables access to a `.cmp` resource in a URL. You can only access a `.app` resource.	Enables a `.cmp` resource to be addressed in a URL.	Similar to `PROD` mode
Google Closure Compiler	Uses the Google Closure Compiler to optimize the JavaScript code. The method names and code are heavily obfuscated.	Uses the Google Closure Compiler to lightly obfuscate the names of non-exported JavaScript methods. This is meant to avoid unintentional usage of non-exported methods.	Does not use Google Closure Compiler
Caching	Caches code. When a file change is detected, this mode performs a full closure compile on all units.	Caches code. When a file change is detected, this mode clears the cache and recompiles definitions.	Similar to `PROD` mode

Test Modes

Use these modes for running different flavors of tests. The various test modes mainly expose extra JavaScript calls that are not available in runtime modes.

In all test modes, caching of registries between tests is disabled. If you modify a cached definition in a test, the modified cached definition is not visible to subsequent tests.

Mode	Usage
`JSTEST`	Use for running component tests. If your component or app has a `<componentName>Test.js` file in its bundle, a browser page is displayed to run the tests. A tab is displayed for each test case in your test suite. Each tab contains an iframe that loads the component in `AUTOJSTEST` mode and runs the single test case. The test results are displayed below the iframe. For a successful test run, the tab turns green; for a failure, it turns red.
`JSTESTDEBUG`	Use for debugging component tests. Similar to `JSTEST` mode but doesn't use the Google Closure Compiler.
`AUTOJSTEST`	Used by `JSTEST` mode when running inside the iframe for a test case. It enables extra JavaScript needed to execute the test case. Use this mode by requesting the component or app containing the test in `JSTEST` mode.
`AUTOJSTESTDEBUG`	Used by `JSTESTDEBUG` mode when running inside the iframe for a test case. It enables extra JavaScript needed to execute the test case. Use this mode by requesting the component or app containing the test in `JSTESTDEBUG` mode.
`PTEST`	Use for running performance tests using the Jiffy Graph UI. Loads Jiffy performance test tools and enables the Jiffy Graph UI. Jiffy is an end-to-end real-world web page instrumentation and measurement suite. This mode doesn't use the Google Closure Compiler.
`CADENCE`	Use for running performance tests if you want to use Jiffy metrics and track the numbers server-side. Loads and runs Jiffy performance test tools and logs the results on the server. Cadence tests use Jiffy, but don't load the Jiffy Graph UI.
`SELENIUM`	Use for tests with Selenium, a software testing framework for web apps. This mode uses the Google Closure Compiler.
`SELENIUMDEBUG`	Similar to `SELENIUM` mode but doesn't use the Google Closure Compiler.
`UTEST`	Used for running unit tests against the framework. It allows developers of the framework to enable some debug code only during testing.

Mode	Usage
`FTEST`	Similar to `UTEST` mode, but used for functional tests instead of unit tests. This mode may expose different debug code than `UTEST` mode.

SEE ALSO:
Component Bundles
Setting the Default Mode
Testing and Debugging Components

Controlling Available Modes

You can customize the set of available modes in your application by writing a Java class that implements the `getAvailableModes()` method in the `ConfigAdapter` interface. The default implementation in `ConfigAdapterImpl` makes all modes available.

So, if you want to use your own configuration to limit the modes in certain environments, such as a production environment, you could limit the modes to only allow `PROD` mode. This would ensure that `PROD` mode is used for all requests. The default mode is not used if it's not also included in the list of available modes.

SEE ALSO:
Modes Reference
Setting the Default Mode
Setting the Mode for a Request

Setting the Default Mode

The default mode is `DEV`. This is defined in the `ConfigAdapterImpl` Java class.

You can change the default mode to `PROD` by setting the `aura.production` Java system property to `true`. Do this by adding `-Daura.production=true` to the arguments when you are starting your server.

To set an alternate default mode, write a Java class that implements the `getDefaultMode()` method in the `ConfigAdapter` Java interface.

The default mode is not used if it's not also included in the list of available modes.

SEE ALSO:
Controlling Available Modes
Setting the Mode for a Request
Modes Reference

Setting the Mode for a Request

Each application has a default mode, but you can change the mode for each HTTP request by setting the `aura.mode` parameter in the query string. If the requested mode is in the list of available modes, the response for that mode is returned. Otherwise, the default mode is used.

For example, let's assume that `DEV` and `PROD` are in the set of the available modes. If the default mode is `DEV` and you want to see the response in `PROD` mode, use `aura.mode=PROD` in the query string of the request URL. For example:

```
http://<your server>/demo/test.app?aura.mode=PROD
```

SEE ALSO:

Modes Reference

Setting the Default Mode

Controlling Available Modes

CHAPTER 14 Debugging

In this chapter ...

There are a few basic tools and techniques that can help you to debug applications.

Use Chrome DevTools to debug your client-side code.

- To open DevTools on Windows and Linux, press Control-Shift-I in your Google Chrome browser. On Mac, press Option-Command-I.
- To quickly find which line of code is failing, enable the **Pause on all exceptions** option before running your code.

To learn more about debugging JavaScript on Google Chrome, refer to the Google Chrome's DevTools website.

Log Messages

To help debug your client-side code, you can write output to the JavaScript console of a web browser using `console.log()` if your browser supports it..

For instructions on using the JavaScript console, refer to the instructions for your web browser.

Use the `$A.log(string[, error])` method to output a log message to the JavaScript console.

The first parameter is the string to log.

The optional second parameter is an error object that can include more detail.

Note: `$A.log()` doesn't output by default in `PROD` or `PRODDEBUG` modes. To log messages in `PROD` or `PRODDEBUG` modes, see Logging in Production Modes on page 287. Alternatively, use `console.log()` if your browser supports it.

For example, `$A.log("This is a log message")` outputs to the JavaScript console:

```
This is a log message
```

Adding `$A.log("The name of the action is: " + this.getDef().getName())` in an action called `openNote` in a client-side controller outputs to the JavaScript console:

```
The name of the action is: openNote
```

The output is also sent to the Aura Debug Tool.

Logging in Production Modes

To log messages in `PROD` or `PRODDEBUG` modes, write a custom logging function. You must use `$A.logger.subscribe(String level, function callback)` to subscribe to log messages at a certain severity level.

The first parameter is the severity level you're subscribing to. The valid values are:

- `ASSERT`
- `ERROR`
- `INFO`
- `WARNING`

The second parameter is the callback function that will be called when a message at the subscribed severity level is logged.

Note that `$A.log()` logs a message at the `INFO` severity level. Adding `$A.logger.subscribe("INFO", logCustom)` causes `$A.log()` to log using the custom `logCustom()` function you define.

Let's look at some sample JavaScript code in a client-side controller.

```
({
    sampleControllerAction: function(cmp) {
        // subscribe to severity levels
        $A.logger.subscribe("INFO", logCustom);
        // Following subscriptions not exercised here but shown for completeness
        //$A.logger.subscribe("WARNING", logCustom);
        //$A.logger.subscribe("ASSERT", logCustom);
        //$A.logger.subscribe("ERROR", logCustom);

        $A.log("log one arg");
```

```
        $A.log("log two args", {message: "drat and double drat"});

        function logCustom(level, message, error) {
            console.log(getTimestamp(), "logCustom: ", arguments);
        }

        function getTimestamp() {
            return new Date().toJSON();
        }
    }

})
```

`$A.logger.subscribe("INFO", logCustom)` subscribes so that messages logged at the `INFO` severity level will call the `logCustom()` function. In this case, `logCustom()` simply logs the message to the console with a timestamp.

The `$A.log()` calls log messages at the `INFO` severity level, which matches the subscription and invokes the `logCustom()` callback.

Warning Messages

To help debug your client-side code, you can use the `warning()` method to write output to the JavaScript console of your web browser.

Use the `$A.warning(string)` method to write a warning message to the JavaScript console. The parameter is the message to display.

For example, `$A.warning("This is a warning message.");` outputs to the JavaScript console.

```
This is a warning message.
```

The output is also sent to the Aura Debug Tool.

Note: `$A.warning()` doesn't output by default in `PROD` or `PRODDEBUG` modes. To log warning messages in `PROD` or `PRODDEBUG` modes, use `$A.logger.subscribe("WARNING", logCustom)`, where `logCustom()` is a custom function that you define. For more information, see Logging in Production Modes on page 287.

For instructions on using the JavaScript console, refer to the instructions for your web browser.

CHAPTER 15 Fixing Performance Warnings

In this chapter ...

A few common performance anti-patterns in code prompt the framework to log warning messages to the browser console. Fix the warning messages to speed up your components!

The warnings display in the browser console only if you enabled debug mode.

SEE ALSO:

Enable Debug Mode for Lightning Components

`<aura:if>`—Clean Unrendered Body

This warning occurs when you change the `isTrue` attribute of an `<aura:if>` tag from `true` to `false` in the same rendering cycle. The unrendered body of the `<aura:if>` must be destroyed, which is avoidable work for the framework that slows down rendering time.

Example

This component shows the anti-pattern.

```
<!--c:ifCleanUnrendered-->
<aura:component>
    <aura:attribute name="isVisible" type="boolean" default="true"/>
    <aura:handler name="init" value="{!this}" action="{!c.init}"/>

    <aura:if isTrue="{!v.isVisible}">
        <p>I am visible</p>
    </aura:if>
</aura:component>
```

Here's the component's client-side controller.

```
/* c:ifCleanUnrenderedController.js */
({
    init: function(cmp) {
        /* Some logic */
        cmp.set("v.isVisible", false); // Performance warning trigger
    }
})
```

When the component is created, the `isTrue` attribute of the `<aura:if>` tag is evaluated. The value of the `isVisible` attribute is `true` by default so the framework creates the body of the `<aura:if>` tag. After the component is created but before rendering, the `init` event is triggered.

The `init()` function in the client-side controller toggles the `isVisible` value from `true` to `false`. The `isTrue` attribute of the `<aura:if>` tag is now `false` so the framework must destroy the body of the `<aura:if>` tag. This warning displays in the browser console only if you enabled debug mode.

```
WARNING: [Performance degradation] markup://aura:if ["5:0"] in c:ifCleanUnrendered ["3:0"]
needed to clear unrendered body.
```

Click the expand button beside the warning to see a stack trace for the warning.

Click the link for the `ifCleanUnrendered` entry in the stack trace to see the offending line of code in the Sources pane of the browser console.

How to Fix the Warning

Reverse the logic for the `isTrue` expression. Instead of setting the `isTrue` attribute to `true` by default, set it to `false`. Set the `isTrue` expression to true in the `init()` method, if needed.

Here's the fixed component:

```
<!--c:ifCleanUnrenderedFixed-->
<aura:component>
    <!-- FIX: Change default to false.
         Update isTrue expression in controller instead. -->
    <aura:attribute name="isVisible" type="boolean" default="false"/>
    <aura:handler name="init" value="{!this}" action="{!c.init}"/>

    <aura:if isTrue="{!v.isVisible}">
        <p>I am visible</p>
    </aura:if>
</aura:component>
```

Here's the fixed controller:

```
/* c:ifCleanUnrenderedFixedController.js */
({
    init: function(cmp) {
        // Some logic
        // FIX: set isVisible to true if logic criteria met
        cmp.set("v.isVisible", true);
    }
})
```

SEE ALSO:

Enable Debug Mode for Lightning Components

`<aura:iteration>`—Multiple Items Set

This warning occurs when you set the `items` attribute of an `<aura:iteration>` tag multiple times in the same rendering cycle.

There's no easy and performant way to check if two collections are the same in JavaScript. Even if the old value of `items` is the same as the new value, the framework deletes and replaces the previously created body of the `<aura:iteration>` tag.

Example

This component shows the anti-pattern.

```
<!--c:iterationMultipleItemsSet-->
<aura:component>
    <aura:attribute name="groceries" type="List"
                    default="[ 'Eggs', 'Bacon', 'Bread' ]"/>

    <aura:handler name="init" value="{!this}" action="{!c.init}"/>

    <aura:iteration items="{!v.groceries}" var="item">
        <p>{!item}</p>
```

```
    </aura:iteration>
</aura:component>
```

Here's the component's client-side controller.

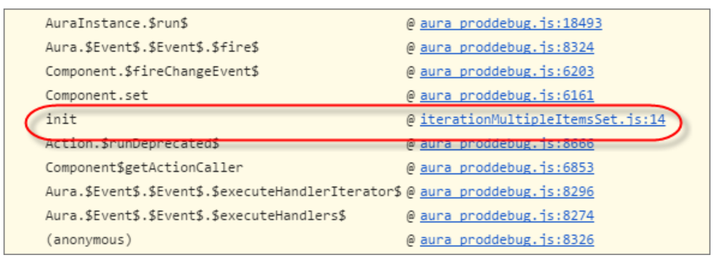
```
/* c:iterationMultipleItemsSetController.js */
({
    init: function(cmp) {
        var list = cmp.get('v.groceries');
        // Some logic
        cmp.set('v.groceries', list); // Performance warning trigger
    }
})
```

When the component is created, the `items` attribute of the `<aura:iteration>` tag is set to the default value of the `groceries` attribute. After the component is created but before rendering, the `init` event is triggered.

The `init()` function in the client-side controller sets the `groceries` attribute, which resets the `items` attribute of the `<aura:iteration>` tag. This warning displays in the browser console only if you enabled debug mode.

```
WARNING: [Performance degradation] markup://aura:iteration [id:5:0] in
c:iterationMultipleItemsSet ["3:0"]
had multiple items set in the same Aura cycle.
```

Click the expand button beside the warning to see a stack trace for the warning.



Click the link for the `iterationMultipleItemsSet` entry in the stack trace to see the offending line of code in the Sources pane of the browser console.

How to Fix the Warning

Make sure that you don't modify the `items` attribute of an `<aura:iteration>` tag multiple times. The easiest solution is to remove the default value for the `groceries` attribute in the markup. Set the value for the `groceries` attribute in the controller instead.

The alternate solution is to create a second attribute whose only purpose is to store the default value. When you've completed your logic in the controller, set the `groceries` attribute.

Here's the fixed component:

```
<!--c:iterationMultipleItemsSetFixed-->
<aura:component>
    <!-- FIX: Remove the default from the attribute -->
    <aura:attribute name="groceries" type="List" />
    <!-- FIX (ALTERNATE): Create a separate attribute containing the default -->
    <aura:attribute name="groceriesDefault" type="List"
                default="[ 'Eggs', 'Bacon', 'Bread' ]"/>
```

```
    <aura:handler name="init" value="{!this}" action="{!c.init}"/>

    <aura:iteration items="{!v.groceries}" var="item">
        <p>{!item}</p>
    </aura:iteration>
</aura:component>
```

Here's the fixed controller:

```
/* c:iterationMultipleItemsSetFixedController.js */
({
    init: function(cmp) {
        // FIX (ALTERNATE) if need to set default in markup
        // use a different attribute
        // var list = cmp.get('v.groceriesDefault');
        // FIX: Set the value in code
        var list = ['Eggs', 'Bacon', 'Bread'];
        // Some logic
        cmp.set('v.groceries', list);
    }
})
```

SEE ALSO:

Enable Debug Mode for Lightning Components

CHAPTER 16 Measuring Performance with `MetricsService`

In this chapter ...

`MetricsService` enables you to instrument and measure the performance of your code and the framework during development, testing, or production usage. With `MetricsService`, you can abstract your performance marks and measures using plugins. This leads to a clean separation between functional code and instrumentation code that measures the performance of the functional code.

The framework is well instrumented already. You can take advantage of the underlying framework measurements and get insight into the performance of your code by adding a mark or transaction.

Here are some core concepts for the `MetricsService`.

Mark

A mark measures a specific event. Use a mark to measure an interval of a larger transaction.

Transaction

A transaction enables you to track all optional marks that occur in between the transaction start and end time. A mark measures a specific event. A transaction that doesn't contain any marks still tracks useful information about the time taken to complete an operation.

Beacon

A beacon is a component that receives the metrics and sends them somewhere for storage. A beacon abstracts the transport layer for sending collected metrics and transactions.

Plugin

A plugin hooks into the code being measured and enables you to instrument your functional code without adding performance marks directly in your functional code. Add the performance marks in the plugin so that your functional code doesn't get littered with marks. This leads to a clean separation between functional code and instrumentation code that measures the performance of the functional code.

A plugin uses AOP (aspect-oriented programming) and the `MetricsService` API calls to hook into the code being measured.

Adding Performance Transactions

A transaction enables you to track all optional marks that occur in between the transaction start and end time. A mark measures a specific event. A transaction that doesn't contain any marks still tracks useful information about the time taken to complete an operation.

A transaction gives you information about marks that you don't control or own. For example, your transaction could include framework-level marks to track a server request or action caching. This framework-level benchmarking comes for free and can give you valuable insight into the performance of your code.

You can add a transaction directly in your code. Consider adding a transaction when you want to measure an action in production that involves a server trip. This gives you performance data that factors in network latency. You don't need transactions for purely client-side operations as those operations are adequately tested in framework code.

Starting a Transaction

To start a transaction, use `$A.metricsService.transactionStart()`. The syntax is:

```
transactionStart(String ns, String name, Object config)
```

The parameters are:

`String ns`
Optional. Transaction namespace. You can use any value. This parameter doesn't have anything to do with a component's namespace though you can use the component's namespace as a high-level identifier.

`String name`
Transaction name. You can use any value, such as a component or action's name.

`Object config`
Optional custom data to log. Keys in the object are:

`Object` ***`context`***: Custom data for the transaction

`function` ***`postProcess`***: The function to execute before sending the transaction to the beacon

`Boolean` ***`skipPluginPostProcessing`***: If `true`, skip all post processing. This is always set to `true` in `PROD` mode.

Ending a Transaction

To end a transaction, use `$A.metricsService.transactionEnd()`. The syntax is:

```
transactionEnd(String ns, String name, Object config | function)
```

The parameters are:

`String ns`
Optional. Transaction namespace. You can use any value. This parameter doesn't have anything to do with a component's namespace though you can use the component's namespace as a high-level identifier.

`String name`
Transaction name. You can use any value, such as a component or action's name.

`Object config | function`
Optional. This parameter can be an `Object` or a function. The `Object` contains any custom data that you want to log. If a function is set instead, the function is executed before sending the transaction to the beacon. Keys in the object are:

`Object` ***`context`***: Custom data for the transaction `function` ***postProcess***: The function to execute before sending the transaction to the beacon

`Boolean` ***skipPluginPostProcessing***: If `true`, skip all post processing. This is always set to `true` in `PROD` mode.

Tracking a Specific User Action

To track a specific user action, use `$A.metricsService.transaction()`. Tracking a user taking a specific UI action, such as clicking a specific button, can be useful if you want to analyze these UI actions later. The syntax is:

```
transaction(String ns, String name, Object config | function)
```

The parameters are:

`String` ***`ns`***
Optional. Transaction namespace. You can use any value. This parameter doesn't have anything to do with a component's namespace though you can use the component's namespace as a high-level identifier.

`String` ***`name`***
Transaction name. You can use any value, such as a component or action's name.

`Object` ***`config`*** **`| function`**
Optional. This parameter can be an `Object` or a function. The `Object` contains any custom data that you want to log. If a function is set instead, the function is executed before sending the transaction to the beacon. Keys in the object are:

`Object` ***context***: Custom data for the transaction

`function` ***postProcess***: The function to execute before sending the transaction to the beacon

`Boolean` ***skipPluginPostProcessing***: If `true`, skip all post processing. This is always set to `true` in `PROD` mode.

Hook for Callback After Every Transaction Ends

To set a callback to be executed after every transaction ends, use `$A.metricsService.onTransactionEnd()`. The syntax is:

```
onTransactionEnd(function callback)
```

The parameters are:

`finction` ***`callback`***
The callback function to be executed after every transaction ends.

Logging Transaction Data

To tell the `MetricsService` where to send your transaction data, register a beacon. When a transaction ends, the `MetricsService` looks for a registered beacon to send the data.

SEE ALSO:

Adding Performance Marks
Logging Data with Beacons

Adding Performance Marks

A mark measures a specific event. Use a mark to measure an interval of a larger transaction.

Starting a Mark

To start a mark, use `$A.metricsService.markStart()`. The syntax is:

```
markStart(String ns, String name, Object context)
```

The parameters are:

`String ns`
Optional. Mark namespace. You can use any value. This parameter doesn't have anything to do with a component's namespace though you can use the component's namespace as a high-level identifier.

`String name`
Mark name. You can use any value, such as a component or action's name.

`Object context`
Optional custom data to log.

To add a mark that doesn't have a separate start and end time, use `$A.metricsService.mark()`.

Ending a Mark

To end a mark, use `$A.metricsService.markEnd()`. The syntax is:

```
markEnd(String ns, String name, Object context)
```

The parameters are:

`String ns`
Optional. Mark namespace. The value must match the ***`ns`*** value in `markStart()`.

`String name`
Mark name. The value must match the ***`ns`*** value in `markStart()`.

`Object context`
Optional custom data to log.

SEE ALSO:
Adding Performance Transactions

Logging Data with Beacons

A beacon is a component that receives the metrics and sends them somewhere for storage. A beacon abstracts the transport layer for sending collected metrics and transactions.

A beacon must contain a `sendData()` function that encapsulates all data logging. The beacon markup uses an `<aura:method>` tag with `id` and `transaction` attributes to define the `sendData()` function. For example:

```
<aura:method name="sendData">
    <aura:attribute name="id" type="Object" />
```

```
    <aura:attribute name="transaction" type="Object" />
</aura:method>
```

The `sendData()` function can contain any custom logic to log the performance data. Typically, it calls a server-side caboose action to log the data.

To register a beacon for all transactions, add this JavaScript code:

```
$A.metricsService.registerBeacon(component);
```

The `init` handler for a component is a typical place to register a beacon.

SEE ALSO:

Adding Performance Transactions

aura:method

Calling a Server-Side Action

Caboose Actions

Invoking Actions on Component Initialization

Abstracting Measurement with Plugins

A plugin hooks into the code being measured and enables you to instrument your functional code without adding performance marks directly in your functional code. Add the performance marks in the plugin so that your functional code doesn't get littered with marks. This leads to a clean separation between functional code and instrumentation code that measures the performance of the functional code.

A plugin uses AOP (aspect-oriented programming) and the `MetricsService` API calls to hook into the code being measured.

Create a plugin when you want to test the performance of your code without adding marks in the functional code. The framework has several plugins for performance testing of different features. The plugins can be disabled in `PROD` mode so that the instrumentation doesn't adversely affect performance.

Tip: Your plugin code runs on every call to an instrumented function. Be selective in using plugins in `PROD` mode to limit the instrumentation to the metrics you care about.

You don't have to create your own plugins unless you want to instrument a complex code path. Alternatively, consider adding a plugin if you don't have write access to the underlying code that you want to measure, or if the code is called from multiple places and you don't want to add marks in all those places.

These are the most important methods that you can customize for your plugin.

`initialize`
: Called by `MetricsService` before bootstrapping the framework so you can bind your before and after hooks using the `instrument()` method of `MetricsService`.

`enable`
: Enables the plugin.

`disable`
: Disables the plugin.

`postProcess`
: The method called before sending the transaction in `DEV` mode. Add logic to massage the payload that the transaction aggregates.

Tip: The best way to understand plugins is to look at some existing code. For an example of a plugin, see `ClientServiceMetricsPlugin.js` in the open source git repo.

The plugin uses `$A.metricsService.registerPlugin()` to register itself.

```
// Register the plugin
$A.metricsService.registerPlugin({
    "name"   : ClientServiceMetricsPlugin.NAME,
    "plugin" : ClientServiceMetricsPlugin
});
```

You can add a plugin in any file as long as it calls `$A.metricsService.registerPlugin()`.

SEE ALSO:

Adding Performance Marks

End-to-End `MetricsService` Example

Let's tie it all together by creating a beacon and a sample component that creates a transaction and a mark. These metrics are sent to the beacon.

IN THIS SECTION:

Step 1: Create a Beacon Component

Add a beacon component that receives the metrics data.

1. Add the markup for the beacon.

```
<!--c:metricsBeacon-->
<aura:component>
    <aura:handler name="init" value="{!this}" action="{!c.doInit}"/>

    <aura:method name="sendData">
        <aura:attribute name="id" type="Object"/>
        <aura:attribute name="transaction" type="Object"/>
    </aura:method>
</aura:component>
```

   The component doesn't have any UI output. It just sets up the `sendData` method for the beacon.

2. Add the client-side controller code.

```
/*metricsBeaconController.js*/
({
    doInit : function(component, event, helper) {
        $A.metricsService.registerBeacon(component);
```

```
    },

    sendData: function (cmp, event, helper) {
        var args = event.getParams().arguments;

        // Log to console as an example.
        // In production-quality code, data would be logged
        // and persisted with a caboose server-side action
        console.log("in beacon: ", args);
    }
})
```

The `doInit()` function registers the beacon. The `init` event configured in the beacon's markup triggers `doInit()`.

This simple beacon logs the output but in production-quality code, you could persist the performance data for analysis.

SEE ALSO:

Logging Data with Beacons

Step 2: Add a Transaction and Mark

Add a component that contains a transaction and a mark.

1. Add the component markup.

```
<!--c:metricsSample-->
<aura:component>
    <c:metricsBeacon/>
    <ui:button label="Log Transaction" press="{!c.logTrans}"/>
</aura:component>
```

The markup includes a reference to the beacon component so that the beacon is loaded.

When you click the button, it will log a transaction after we set up the client-side controller.

2. Add the client-side controller code.

```
/*metricsSampleController.js*/
({
    logTrans : function(cmp) {
        console.log("in logTrans");

        $A.metricsService.transactionStart('c', 'sampleTrans',
          {context : Date.now()}
        );
        // imagine a server call here

        $A.metricsService.markStart('c', 'sampleMark');
        // imagine some client-side component creation here
        $A.metricsService.markEnd('c', 'sampleMark');

        $A.metricsService.transactionEnd('c', 'sampleTrans');
    }
})
```

The client-side controller creates a transaction and mark. This sample demonstrates the scaffolding and doesn't include production-quality code that would make a server call and perform some client-side processing. Adding a mark within the transaction can give you more insight into where time is consumed in a transaction.

3. Click the **Log Transaction** button in `c:metricsSample`.
   Look in the browser's console log for the metrics.

SEE ALSO:

Adding Performance Transactions
Adding Performance Marks

CUSTOMIZING AURA

CHAPTER 17 Plugging in Custom Code with Adapters

In this chapter ...

Aura has a set of adapters that provide default implementations of functionality that you can override.

For example, the localization adapter provides the default behavior for working with labels and locales. You may want to override this behavior for your own localization requirements.

Think of an adapter as a plugin point for your custom code. It's useful to contrast this with the Aura Integration Service, which enables you to inject Aura components into a Web app that is not developed in Aura.

`AuraAdapter` is the base marker interface for all adapters. You can find all the adapter interfaces in the `org.auraframework.adapter` package.

SEE ALSO:

Default Adapters

Overriding Default Adapters

Accessing Components from Non-Aura Containers

Default Adapters

Aura has a set of default adapters.

Adapter	Description
`ComponentLocationAdapter`	Provides the default location for storing component source files. The default is to store components on the filesystem but you could override this to store them in a database.
`ConfigAdapter`	Provides many defaults, including the set of available modes, and the version of the Aura framework.
`ContextAdapter`	Provides the default context. Every request in Aura is associated with a context. After initial loading of an app, each subsequent request is an XHR POST that contains your Aura context configuration, which includes the mode to run in, the name of the app, and the namespaces that already have metadata loaded on the client.
`ExceptionAdapter`	Provides the default exception handling. The default is to log the exception.
`ExpressionAdapter`	Provides the default expression language.
`FormatAdapter`	Provides the default implementations for reading and writing different resources, such as Aura markup, CSS, or JSON.
`GlobalValueProviderAdapter`	Provides the global value providers. Global value providers are global values, such as `$Label`, that a component can use in expressions.
`JsonSerializerAdapter`	Provides the default JSON serializers. You can use this adapter to customize how Aura locates the correct serializer implementation to marshall objects to and from JSON.
`LocalizationAdapter`	Provides the default label and locale handling.
`LoggingAdapter`	Provides the default logging.
`PrefixDefaultsAdapter`	Provides the default prefixes for Aura definitions. Each definition describes metadata for an element, such as a component, event, controller, or model.
`RegistryAdapter`	Provides the default registries. Registries store metadata definitions. Some registries last for the duration of a request, while others are cached for the lifetime of an app.
`StyleAdapter`	Provides the default CSS themes.

SEE ALSO:

Plugging in Custom Code with Adapters

Overriding Default Adapters

Overriding Default Adapters

There are several ways to override the default adapters.

To override one of the default adapters:

1. Extend an existing adapter or create a new class that implements the adapter interface that you're overriding.

2. Use the `@Override` annotation on each interface method that you implement.

SEE ALSO:

Plugging in Custom Code with Adapters
Default Adapters
Customizing your Label Implementation

CHAPTER 18 Accessing Components from Non-Aura Containers

In this chapter ...

The Aura Integration Service enables plugging Aura components into non-Aura HTML containers.

Because Aura requires an app to start and to render components, the Aura Integration Service creates and manages an internal integration app on your behalf for the components you're embedding. This makes it easy to use Aura components in an HTML-based application.

Also, the Aura Integration Service allows partial page updates. You can add additional components to a page that has already been loaded and after an app has already been created.

An Aura component instance is embedded in a page inside a script tag and is bound to its parent DOM element.

The Aura Integration Service provides a set of Java APIs that allow you to embed a component. The Java APIs are included in the following interfaces and their class implementations.

- IntegrationService Interface (implemented by `IntegrationServiceImpl`): Enables the creation of an integration using the `createIntegration()` method.
- Integration Interface (implemented by `IntegrationImpl`): Enables adding components using the `injectComponent()` method.

Note: The Aura History Service and Aura Layout Service are not supported with the Aura Integration Service, and hence embedded components can't make use of these services.

SEE ALSO:

Customizing Behavior with Modes

Component IDs

Add an Aura button inside an HTML div container

The Aura Integration Service enables you to plug Aura components into HTML containers.

1. Create a Java instance of the Aura Integration Service.

```
IntegrationService svc = Aura.getIntegrationService();
```

2. Create an integration, which enables you to embed components in your page.
   - For the first argument, pass the context path. For servlets in the default root context, it is an empty string.
   - For the second argument, pass the mode. In this example, we're specifying the `DEV` mode.
   - For the third argument, pass a Boolean value to indicate whether Aura should create an integration app or not. In this case, we're passing `true`. If you want to perform a partial page update, pass `false` for the third argument. This enables you to add more components after a page has been loaded and an app has already been created.

```
Integration integ = svc.createIntegration("", Mode.DEV, true);
```

3. Call the `injectComponent` method to embed a component in a parent container.
   - For the first argument, pass the component's fully qualified name. In this case, it is `"ui:button"`.
   - For the second argument, pass the component's attributes as a map. This example creates a map with one attribute and passes it as the second argument.
   - For the third argument, pass the local component ID. In this example, it is `"button1"`.
   - For the fourth argument, pass the DOM identifier for the parent container element. In this example, it is `"div1"`.
   - For the fifth argument, pass a buffer that will contain the script output.
   - For the sixth argument, pass a boolean set to `true` to use asynchronous component creation for the injected component instead of the default method of printing the component HTML to the page. The asynchronous option is more performant if you are injecting multiple components.

```
Map<String, Object> attributes = Maps.newHashMap();
attributes.put("label", "Click Me");
Appendable out = new StringBuffer();
boolean async = true;
integration.injectComponent("ui:button", attributes, "button1", "div1", out, async);
```

Example: This is the full listing of the sample.

```
IntegrationService svc = Aura.getIntegrationService();
Integration integration = svc.createIntegration("", Mode.DEV, true);
Map<String, Object> attributes = Maps.newHashMap();
attributes.put("label", "Click Me");
Appendable out = new StringBuffer();
boolean async = true;
integration.injectComponent("ui:button", attributes, "button1", "div1", out, async);
```

CHAPTER 19 Customizing Data Type Conversions

In this chapter ...

A custom converter enables the conversion of one Java type to another Java type for client data sent to the server or for server markup data.

When a client calls a server-side controller action, data that the client sends, such as input parameters for a server action, is sent in JSON format. The JSON representation of data is converted to target Java types on the server. Similarly, values in Aura markup on the server, such as component attribute values, are evaluated as Java strings. These strings are converted to corresponding Java types. For primitive Java types, the type conversion is implicit and doesn't require the addition of any converters. For example, a JSON string is converted to a Java string, and a JSON list is converted to a Java ArrayList. For custom types, or when there is no one-to-one mapping between the source value and the target type, Aura calls the custom converter that you provide to create an instance of the custom Java type corresponding to the JSON representation on the client or the markup attribute value on the server.

An example of a custom converter is a converter used to convert comma-delimited string values to an ArrayList. A component attribute of type List can have a default value in markup of a comma-delimited string of values. Aura converts this attribute string value into an ArrayList by calling the custom String to ArrayList converter.

SEE ALSO:

Custom Java Class Types

Creating Server-Side Logic with Controllers

Supported aura:attribute Types

Registering Custom Converters

Register a custom converter to enable conversion of one Java type to another Java type when sending data to and from the server.

To register a custom converter:

1. Create a class that implements the `Converter` interface. Add `implements Converter<Type1, Type2>` at the end of the first line of your class definition, after the class name. Replace *`Type1`* with the original Java type and *`Type2`* with the target Java type. Next, implement each method in the `Converter` interface. For better readability of your code, we recommend you name the class using the format *`Type1`*`To`*`Type2`*`Converter`. This is an example of a skeletal class implementing the `Converter` interface. *`Type1`* and *`Type2`* are placeholders for the Java original type and the converted type, respectively.

```
public class Type1ToType2Converter implements Converter<Type1, Type2> {

    @Override
    public Type2 convert(Type1 value) {
        // Convert value into a value of Type2 and return it.
        // Return converted value.
    }

    @Override
    public Class<Type1> getFrom() {
        // return Type1.class;
    }

    @Override
    public Class<Type2> getTo() {
        // return Type2.class;
    }

    @Override
    public Class<?>[] getToParameters() {
        // Return the types contained in the custom type.
    }

}
```

2. Create another class annotated with `@AuraConfiguration`. The class must be in the `configuration` package.
3. Add a `public static` method to this class annotated with `@Impl`. The method should return either the `Converter<?, ?>` type or `Converter<`*`Type1`*`, `*`Type2`*`>` with the actual original and target Java types. The method returns a new instance of the class you created earlier, which implements the `Converter` interface.

```
package configuration;

@AuraConfiguration
public class MyTypeConverterConfig {
   @Impl
    public static Converter<Type1, Type2> exampleTypeConverter() {
        return new Type1ToType2Converter();
    }
}
```

4. To specify additional conversions, repeat the previous steps. Each new conversion requires a converter implementation class and the addition of a corresponding method to the Aura configuration class.

Custom Converters

Here are a few examples of custom converters.

Example 1: Custom Type Conversion for a Component Attribute

This example shows how to add a converter to convert an attribute string value to the corresponding custom type. It contains the definition of the custom type, `MyCustomType`, an example of the attribute, the corresponding converter, and a method in the Aura configuration class.

This is the definition of the custom type, `MyCustomType`.

```
package doc.sample;

public class MyCustomType implements JsonSerializable {
    private String val;

    public MyCustomType(String val) {
        this.val = val;
    }

    @Override
    public void serialize(Json json) throws IOException {
        json.writeString(val);
    }
}
```

This is the attribute of type `MyCustomType` with a default value of `"x"`.

```
<aura:attribute name="myObj" type="java://doc.sample.MyCustomType" default="x"/>
```

This is the converter implementation for converting a string (the attribute value) to an object of type `MyCustomType` (the target Java type).

```
public class StringToMyCustomTypeConverter implements Converter<String, MyCustomType> {

    @Override
    public MyCustomType convert(String value) {
        return new MyCustomType(value);
    }

    @Override
    public Class<String> getFrom() {
        return String.class;
    }

    @Override
    public Class<MyCustomType> getTo() {
        return MyCustomType.class;
    }

    @Override
    public Class<?>[] getToParameters() {
        return null;
```

```
    }

}
```

This is the corresponding Aura Configuration method.

```
package configuration;

@AuraConfiguration
public class MyCustomTypeConverterConfig {
   @Impl
    public static Converter<String, MyCustomType> exampleTypeConverter() {
        return new StringToMyCustomTypeConverter();
    }
}
```

Example 2: Parameterized Type Conversion for a Server Action Call

This example shows how to add a converter to convert the type of a parameter passed to a server-side controller action call that a client makes. The target type of the conversion is a parameterized type, `List<MyCustomType>`, which is a list of `MyCustomType` objects.

This example is based on the `MyCustomType` class defined earlier.

This is the client call to the `accept` action on the server-side controller. The client passes an array of three string values that corresponds to a list of `MyCustomType` objects. Because the parameter value is an array of objects, the original type of the conversion is ArrayList.

```
custom : function(c) {
    var a = c.get("c.accept");
    a.setParams({myObjs:["x","y","z"]});
    $A.enqueueAction(a);
},
```

This is how the `accept` method looks in the server-side controller. Notice the parameter of the `accept` method is of type `List<MyCustomType>`. This is the target type of the conversion.

```
@AuraEnabled
public static void accept(@Key("myObjs") List<MyCustomType> myObjs) {
    for (MyCustomType obj : myObjs) {
        System.err.println("MyCustomType:" + obj);
    }
}
```

This is the converter implementation that converts an ArrayList (the parameter array sent by the client) to a List of `MyCustomType` objects on the server.

```
public class ArrayListToMyCustomTypeListConverter implements Converter<ArrayList, List> {


    @Override
    public List<MyCustomType> convert(ArrayList value) {
        List<MyCustomType> retList = Lists.newLinkedList();
        for (Object part : value) {
            retList.add(new MyCustomType(part.toString()));
        }
```

```
        return retList;
    }

    @Override
    public Class<ArrayList> getFrom() {
        return ArrayList.class;
    }

    @Override
    public Class<List> getTo() {
        return List.class;
    }

    @Override
    public Class<?>[] getToParameters() {
        return new Class[] { MyCustomType.class };
    }
}
```

This is the corresponding Aura Configuration method.

```
package configuration;

@AuraConfiguration
public class MyCustomTypeListConverterConfig {
   @Impl
    public static Converter<ArrayList, List<MyCustomType>> exampleTypeConverter() {
        return new ArrayListToList<MyCustomType>Converter();
    }
}
```

Example 3: Parameterized Type Conversion for a Component Attribute

This example is similar to the previous one except that the conversion is done for an attribute value. In this example, consider the following attribute that holds a list of `MyCustomType` objects and with a default value of `"x,y,z"`. Because the attribute value is a string, the original type of the conversion is String. The target type is `List<MyCustomType>`.

This example is based on the `MyCustomType` class defined earlier.

```
<aura:attribute name="myObjs" type="java://java.util.List<doc.sample.MyCustomType>"
default="x,y,z"/>
```

This is the converter implementation for converting a string to a list of `MyCustomType` objects.

```
public class StringToMyCustomTypeListConverter implements Converter<String, List> {

    @Override
    public List<MyCustomType> convert(String value) {
        List<MyCustomType> retList = Lists.newLinkedList();
        for (String part : AuraTextUtil.splitSimple(",", value)) {
            retList.add(new MyCustomType(part));
        }
        return retList;
    }
```

```
    @Override
    public Class<String> getFrom() {
        return String.class;
    }

    @Override
    public Class<List> getTo() {
        return List.class;
    }

    @Override
    public Class<?>[] getToParameters() {
        return new Class[] { MyCustomType.class };
    }
}
```

This is the corresponding Aura Configuration method.

```
package configuration;

@AuraConfiguration
public class MyCustomTypeList2ConverterConfig {
   @Impl
    public static Converter<String, List<MyCustomType>> exampleTypeConverter() {
        return new StringToList<MyCustomType>Converter();
    }
}
```

CHAPTER 20 Reference

In this chapter ...

This section contains links to reference documentation.

Reference Doc App

The Reference tab of the doc app includes more reference information, including descriptions and source for the out-of-the-box components that come with the framework, as well as the JavaScript API.

System Tag Reference

System tags represent framework definitions and are not generated via component bundles.

System tags include tags like `aura:method` and `aura:set`, which are all found in the `aura` namespace.

aura:application

An app is a special top-level component whose markup is in a `.app` file.

The markup looks similar to HTML and can contain components as well as a set of supported HTML tags. The `.app` file is a standalone entry point for the app and enables you to define the overall application layout, style sheets, and global JavaScript includes. It starts with the top-level `<aura:application>` tag, which contains optional system attributes. These system attributes tell the framework how to configure the app.

System Attribute	Type	Description
`access`	String	Indicates whether the app can be extended by another app outside of a namespace. Possible values are `internal` (default), `public`, and `global`.
`controller`	String	The server-side controller class for the app. The format is `java://<package.class>`.
`description`	String	A brief description of the app.
`extends`	Component	The app to be extended, if applicable. For example, `extends="namespace:yourApp"`.
`extensible`	Boolean	Indicates whether the app is extensible by another app. Defaults to `false`.
`implements`	String	A comma-separated list of interfaces that the app implements.
`locationChangeEvent`	Event	The framework monitors the location of the current window for changes. If the `#` value in a URL changes, the framework fires an application event. The `locationChangeEvent` defines this event. The default value is `aura:locationChange`. The `locationChange` event has a single attribute called `token`, which is set with everything after the `#` value in the URL.
`model`	String	The model class used to initialize data for the app. The format is `java://<package.class>.`
`preload`	String	Deprecated. Use the aura:dependency tag instead. If you use the `preload` system attribute, the framework internally converts the value to `<aura:dependency>` tags.

System Attribute	Type	Description
`render`	String	Renders the component using client-side or server-side renderers. If not provided, the framework determines any dependencies and whether the application should be rendered client-side or server-side. Valid options are `client` or `server`. The default is `auto`. For example, specify `render="client"` if you want to inspect the application on the client-side during testing.
`renderer`	String	Only use this system attribute if you want to use a custom client-side or server-side renderer. If you don't set a renderer, the framework uses its default rendering, which is sufficient for most use cases. If you don't define this system attribute, your application is autowired to a client-side renderer named **`<appName>`**`Renderer.js`, if it exists in your application bundle.
`template`	Component	The name of the template used to bootstrap the loading of the framework and the app. The default value is `aura:template`. You can customize the template by creating your own component that extends the default template. For example: `<aura:component extends="aura:template" ... >`
`tokens`	String	A comma-separated list of tokens bundles for the application. For example, `tokens="ns:myAppTokens"`. Tokens make it easy to ensure that your design is consistent, and even easier to update it as your design evolves. Define the token values once and reuse them throughout your application.
`useAppcache`	Boolean	Deprecated. Browser vendors have deprecated AppCache, so we followed their lead. Remove the `useAppcache` attribute in the `<aura:application>` tag of your standalone apps (`.app` files) to avoid cross-browser support issues due to deprecation by browser vendors. If you don't currently set `useAppcache` in an `<aura:application>` tag, you don't have to do anything because the default value of `useAppcache` is `false`.

`aura:application` also includes a `body` attribute defined in a `<aura:attribute>` tag. Attributes usually control the output or behavior of a component, but not the configuration information in system attributes.

Attribute	Type	Description
`body`	`Component[]`	The body of the app. In markup, this is everything in the body of the tag.

SEE ALSO:

- Creating Apps
- Using the AppCache
- Application Access Control

aura:component

The root of the component hierarchy. Provides a default rendering implementation.

Components are the functional units of Aura, which encapsulate modular and reusable sections of UI. They can contain other components or HTML markup. The public parts of a component are its attributes and events. Aura provides out-of-the-box components in the `aura` and `ui` namespaces.

Every component is part of a namespace. For example, the `button` component is saved as `button.cmp` in the `ui` namespace can be referenced in another component with the syntax `<ui:button label="Submit"/>`, where `label="Submit"` is an attribute setting.

To create a component, follow this syntax.

```
<aura:component>
    <!-- Optional coponent attributes here -->
    <!-- Optional HTML markup -->
    <div class="container">
        Hello world!
        <!-- Other components -->
    </div>
</aura:component>
```

A component has the following optional attributes.

Attribute	Type	Description
`abstract`	Boolean	Set to `true` if the component is abstract. The default is `false`.
`access`	String	Indicates whether the component can be used outside of its own namespace. Possible values are `internal` (default), `public`, and `global`.
`aura:flavorable`	Boolean	Set to `true` if the component is flavorable. The default is `false`.
`controller`	String	The server-side controller class for the component. The format is `java://<package.class>`.
`defaultFlavor`	String	The comma-separated list of flavor names in the component bundle, defined in the `<componentName>Flavors.css` file.
`description`	String	A description of the component.
`extends`	Component	The component to be extended.
`extensible`	Boolean	Set to `true` if the component can be extended. The default is `false`.
`helper`	String	The external JavaScript helper file to use. If you use an external helper file, the helper methods in your component bundle will not be accessible. The format is `js://namespace.component`.
`implements`	String	A comma-separated list of interfaces that the component implements.

Attribute	Type	Description
isTemplate	Boolean	Set to true if the component is a template. The default is false. A template must have isTemplate="true" set in its <aura:component> tag. `<aura:component isTemplate="true" extends="aura:template">`
model	String	The model class used to initialize data for the component. The format is java://<package.class>.
provider	String	The JavaScript or Java provider, in the format java://<package.class> or js://namespace.component. A provider enables you to use an abstract component in markup. Defining a server-side provider overrides any client-side provider in the component bundle.
render	String	Renders the component using client-side or server-side renderers. If not provided, the framework determines any dependencies and whether the component should be rendered client- or server-side. Valid options are client or server. The default is auto. Specify this attribute in the top-level component. For example, specify render="client" if you want to inspect the component on the client-side during testing.
support	String	The support level for the component. Valid options are PROTO, DEPRECATED, BETA, or GA.
template	Component	The template for this component. A template bootstraps loading of the framework and app. The default template is aura:template. You can customize the template by creating your own component that extends the default template. For example: `<aura:component extends="aura:template" ... >`
whitespace	String	Preserves or removes unnecessary whitespace in the component markup. Valid options are preserve or optimize. The default is optimize.

aura:component includes a body attribute defined in a <aura:attribute> tag. Attributes usually control the output or behavior of a component, but not the configuration information in system attributes.

Attribute	Type	Description
body	Component[]	The body of the component. In markup, this is everything in the body of the tag.

aura:clientLibrary

The `<aura:clientLibrary>` tag enables you to use JavaScript or CSS libraries. Use the tag in a `.cmp` or `.app` resource.

The `<aura:clientLibrary>` tag includes these system attributes.

System Attribute	Description
`modes`	A comma-separated list of modes that use the client library. If no value is set, the library is available for all modes.
`name`	The name of the library. Use this name when you load the library in JavaScript code by calling `$A.clientService.loadClientLibrary(libName, callback)`.
`prefetch`	Specifies whether browsers should download the script to browser cache during idle time. This prefetching can improve app performance by reducing the loading time for scripts. Defaults to `true`. If your component doesn't always use the script, set `prefetch` to `false` and load the library when you need it. Note: The prefetch request isn't guaranteed. Prefetching only works for JavaScript libraries and browsers that support the `<link rel="prefetch" ... />` hint.
`type`	The type of library. Values are `CSS`, or `JS` for JavaScript.

Use the Library

The `<aura:clientLibrary>` tag in markup registers a library for a component or application. For example:

```
<aura:clientLibrary name="libraryName" />
```

To use the library, you must call this method in JavaScript code.

```
$A.clientService.loadClientLibrary(libName, callback)
```

If the library hasn't previously been loaded on the client, this method loads the library. If the `prefetch` attribute is set to `true`, the library can be loaded from browser cache, which avoids an extra server trip and reduces the latency of script loading.

This example shows how to use a library in JavaScript code.

```
$A.clientService.loadClientLibrary("libraryName",
    function() {
        // use the library
    }
);
```

The first argument matches the `name` attribute used for the library in the `<aura:clientLibrary>` tag in markup.

```
<aura:clientLibrary name="libraryName" />
```

The second argument is the callback function that uses the library after it's loaded.

SEE ALSO:

Styling Apps
Using External JavaScript Libraries

aura:dependency

The `<aura:dependency>` tag enables you to declare dependencies, which improves their discoverability by the framework.

The framework automatically tracks dependencies between definitions, such as components, defined in markup. This enables the framework to send the definitions to the browser. However, if a component's JavaScript code dynamically instantiates another component or fires an event that isn't directly referenced in the component's markup, use `<aura:dependency>` in the component's markup to explicitly tell the framework about the dependency. Similarly, add a dependency for resources created in client- or server-side providers. Adding the `<aura:dependency>` tag ensures that a definition, such as a component, and its dependencies are sent to the client, when needed.

For example, adding this tag to a component marks the `sampleNamespace:sampleComponent` component as a dependency.

```
<aura:dependency resource="markup://sampleNamespace:sampleComponent" />
```

Add this tag to component markup to mark the event as a dependency.

```
<aura:dependency resource="markup://sampleNamespace:sampleEvent" type="EVENT"/>
```

Use the `<aura:dependency>` tag if you fire an event in JavaScript code and you're not registering the event in component markup using `<aura:registerEvent>`. Using an `<aura:registerEvent>` tag is the preferred approach.

The `<aura:dependency>` tag includes these system attributes.

System Attribute	Description
`resource`	The resource that the component depends on, such as a component or event. For example, `resource="markup://sampleNamespace:sampleComponent"` refers to the `sampleComponent` in the `sampleNamespace` namespace. Note: Using an asterisk (`*`) for wildcard matching is deprecated. Instead, add an `<aura:dependency>` tag for each resource that's not directly referenced in the component's markup. Wildcard matching can cause save validation errors when no resources match. Wildcard matching can also slow page load time because it sends more definitions than needed to the client.
`type`	The type of resource that the component depends on. The default value is `COMPONENT`. Note: Using an asterisk (`*`) for wildcard matching is deprecated. Instead, add an `<aura:dependency>` tag for each resource that's not directly referenced in the component's markup. Be as selective as possible in the types of definitions that you send to the client. The most commonly used values are: • `COMPONENT` • `EVENT` • `INTERFACE` • `APPLICATION`

System Attribute	Description
	Use a comma-separated list for multiple types; for example: `COMPONENT,APPLICATION`.

SEE ALSO:

- Client-Side Runtime Binding of Components
- Server-Side Runtime Binding of Components
- Dynamically Creating Components
- Fire Component Events
- Fire Application Events

aura:event

An event is represented by the `aura:event` tag, which has the following attributes.

Attribute	Type	Description
`access`	String	Indicates whether the event can be extended or used outside of its own namespace. Possible values are `internal` (default), `public`, and `global`.
`description`	String	A description of the event.
`extends`	Component	The event to be extended. For example, `extends="namespace:myEvent"`.
`type`	String	Required. Possible values are `COMPONENT` or `APPLICATION`.
`support`	String	The support level for the event. Valid options are `PROTO`, `DEPRECATED`, `BETA`, or `GA`.

SEE ALSO:

- Communicating with Events
- Event Access Control

aura:if

`aura:if` renders the content within the tag if the `isTrue` attribute evaluates to true.

The framework evaluates the `isTrue` expression and instantiates components either in its `body` or `else` attribute.

Note: `aura:if` instantiates the components in either its body or the `else` attribute, but not both. `aura:renderIf` instantiates both the components in its body and the `else` attribute, but only renders one. If the state of `isTrue` changes, `aura:if` has to first instantiate the components for the other state and then render them. We recommend using `aura:if` instead of `aura:renderIf` to improve performance.

Attribute Name	Type	Description
else	ComponentDefRef[]	The markup to render when isTrue evaluates to false. Set this attribute using the aura:set tag.
isTrue	string	Required. An expression that determines whether the content is displayed. If it evaluates to true, the content is displayed.

Example

This snippet of markup uses the <aura:if> tag to conditionally display an edit button.

```
<aura:attribute name="edit" type="Boolean" default="true"/>
<aura:if isTrue="{!v.edit}">
    <ui:button label="Edit"/>
    <aura:set attribute="else">
        You can't edit this.
    </aura:set>
</aura:if>
```

If the edit attribute is set to true, a ui:button displays. Otherwise, the text in the else attribute displays.

SEE ALSO:

Best Practices for Conditional Markup

aura:renderIf

aura:interface

The aura:interface tag has the following optional attributes.

Attribute	Type	Description
access	String	Indicates whether the interface can be extended or used outside of its own namespace. Possible values are internal (default), public, and global.
description	String	A description of the interface.
extends	Component	The comma-seperated list of interfaces to be extended. For example, extends="namespace:intfB".
provider	String	The provider for the interface.
support	String	The support level for the interface. Valid options are PROTO, DEPRECATED, BETA, or GA.

SEE ALSO:

Interfaces

Interface Access Control

aura:iteration

`aura:iteration` iterates over a collection of items and renders the body of the tag for each item.

Data changes in the collection are rerendered automatically on the page. `aura:iteration` supports iterations containing components that have server-side dependencies or that can be created exclusively on the client-side.

Attribute Name	Type	Description
body	ComponentDefRef[]	Required. Template to use when creating components for each iteration. You can put any markup in the body. A ComponentDefRef[] stores the metadata of the component instances to create on each iteration, and each instance is then stored in realbody.
end	Integer	The index of the collection to stop at (exclusive).
forceServer	Boolean	Force a server request for the component body. Set to true if the iteration requires any server-side creation. The default is false.
indexVar	String	The variable name to use for the index of each item inside the iteration.
items	List	Required. The collection of data to iterate over.
realbody	Component[]	Do not use. Any value set is ignored. Placeholder for body rendering.
start	Integer	The index of the collection to start at (inclusive).
var	String	Required. The variable name to use for each item inside the iteration.

This example shows how you can use `aura:iteration` exclusively on the client-side with an HTML `meter` tag.

```
<aura:component>
  <aura:iteration items="1,2,3,4,5" var="item">
    <meter value="{!item / 5}"/><br/>
  </aura:iteration>
</aura:component>
```

The output shows five meters with ascending values of one to five.

SEE ALSO:

Client-Side Runtime Binding of Components

Server-Side Runtime Binding of Components

aura:method

Use `<aura:method>` to define a method as part of a component's API. This enables you to directly call a method in a component's client-side controller instead of firing and handling a component event. Using `<aura:method>` simplifies the code needed for a parent component to call a method on a child component that it contains.

The `<aura:method>` tag has these system attributes.

Attribute	Type	Description
`name`	`String`	The method name. Use the method name to call the method in JavaScript code. For example: `cmp.sampleMethod(param1);`
`action`	`Expression`	The client-side controller action to execute. For example: `action="{!c.sampleAction}"` `sampleAction` is an action in the client-side controller. If you don't specify an `action` value, the controller action defaults to the value of the method `name`.
`access`	`String`	The access control for the method. Valid values are: • **internal**—Any component in a system namespace can call the method. A system namespace is a privileged namespace that has access to all components. This is the default access level. • **public**—Any component in the same namespace can call the method. • **global**—Any component in any namespace can call the method.
`description`	`String`	The method description.

Declaring Parameters

An `<aura:method>` can optionally include parameters. Use an `<aura:attribute>` tag within an `<aura:method>` to declare a parameter for the method. For example:

```
<aura:method name="sampleMethod" action="{!c.doAction}"
  description="Sample method with parameters">
    <aura:attribute name="param1" type="String" default="parameter 1"/>
    <aura:attribute name="param2" type="Object" />
</aura:method>
```

Note: You don't need an `access` system attribute in the `<aura:attribute>` tag for a parameter.

Creating a Handler Action

This handler action shows how to access the arguments passed to the method.

```
({
    doAction : function(cmp, event) {
        var params = event.getParam('arguments');
        if (params) {
            var param1 = params.param1;
            // add your code here
        }
    }
})
```

Retrieve the arguments using `event.getParam('arguments')`. It returns an object if there are arguments or an empty array if there are no arguments.

Returning a Value

`aura:method` executes synchronously.

- A synchronous method finishes executing before it returns. Use the `return` statement to return a value from synchronous JavaScript code. See Return Result for Synchronous Code.
- An asynchronous method may continue to execute after it returns. Use a callback to return a value from asynchronous JavaScript code. See Return Result for Asynchronous Code.

SEE ALSO:

Calling Component Methods
Component Events

aura:renderIf

Deprecated. Use `aura:if` instead.

`aura:renderIf` renders the content within the tag if the `isTrue` attribute evaluates to `true`. The previous advice was to only consider using `aura:renderIf` if you expect to show the components for both the `true` and `false` states, and it would require a server round trip to instantiate the components that aren't initially rendered. This advice is no longer relevant. Always use `aura:if` instead.

Attribute Name	Type	Description
`else`	Component[]	The markup to render when `isTrue` evaluates to `false`. Set this attribute using the `aura:set` tag.
`isTrue`	String	Required. An expression that determines whether the content is displayed. If it evaluates to `true`, the content is displayed.

Example

This snippet of markup uses the `<aura:renderIf>` tag to conditionally display an edit button.

```
<aura:attribute name="edit" type="Boolean" default="true">
<aura:renderIf isTrue="{!v.edit}">
    <ui:button label="Edit"/>
    <aura:set attribute="else">
        You can’t edit this.
        <!-- Imagine some components here that need to be created on the server -->
    </aura:set>
</aura:renderIf>
```

If the `edit` attribute is set to `true`, a `ui:button` displays. Otherwise, the text in the `else` attribute displays.

We recommend using `aura:if` instead if the `else` attribute is rarely displayed or if it doesn’t include components that need to be created on the server.

SEE ALSO:

Best Practices for Conditional Markup
aura:if

aura:set

Use `<aura:set>` in markup to set the value of an attribute inherited from a super component, event, or interface.

To learn more, see:

- Setting Attributes Inherited from a Super Component
- Setting Attributes on a Component Reference
- Setting Attributes Inherited from an Interface

Setting Attributes Inherited from a Super Component

Use `<aura:set>` in the markup of a sub component to set the value of an inherited attribute.

Let's look at an example. Here is the `c:setTagSuper` component.

```
<!--c:setTagSuper-->
<aura:component extensible="true">
    <aura:attribute name="address1" type="String" />
    setTagSuper address1: {!v.address1}<br/>
</aura:component>
```

`c:setTagSuper` outputs:

```
setTagSuper address1:
```

The `address1` attribute doesn't output any value yet as it hasn't been set.

Here is the `c:setTagSub` component that extends `c:setTagSuper`.

```
<!--c:setTagSub-->
<aura:component extends="c:setTagSuper">
```

```
    <aura:set attribute="address1" value="808 State St" />
</aura:component>
```

c:setTagSub outputs:

```
setTagSuper address1: 808 State St
```

sampleSetTagExc:setTagSub sets a value for the address1 attribute inherited from the super component, c:setTagSuper.

Warning: This usage of <aura:set> works for components and abstract components, but it doesn't work for interfaces. For more information, see Setting Attributes Inherited from an Interface on page 327.

If you're using a component by making a reference to it in your component, you can set the attribute value directly in the markup. For example, c:setTagSuperRef makes a reference to c:setTagSuper and sets the address1 attribute directly without using aura:set.

```
<!--c:setTagSuperRef-->
<aura:component>
    <c:setTagSuper address1="1 Sesame St" />
</aura:component>
```

c:setTagSuperRef outputs:

```
setTagSuper address1: 1 Sesame St
```

SEE ALSO:

Component Body
Inherited Component Attributes
Setting Attributes on a Component Reference

Setting Attributes on a Component Reference

When you include another component, such as <ui:button>, in a component, we call that a component reference to <ui:button>. You can use <aura:set> to set an attribute on the component reference. For example, if your component includes a reference to <ui:button>:

```
<ui:button label="Save">
    <aura:set attribute="buttonTitle" value="Click to save the record"/>
</ui:button>
```

This is equivalent to:

```
<ui:button label="Save" buttonTitle="Click to save the record" />
```

The latter syntax without aura:set makes more sense in this simple example. You can also use this simpler syntax in component references to set values for attributes that are inherited from parent components.

aura:set is more useful when you want to set markup as the attribute value. For example, this sample specifies the markup for the else attribute in the aura:if tag.

```
<aura:component>
    <aura:attribute name="display" type="Boolean" default="true"/>
    <aura:if isTrue="{!v.display}">
        Show this if condition is true
```

```
        <aura:set attribute="else">
            <ui:button label="Save" press="{!c.saveRecord}" />
        </aura:set>
    </aura:if>
</aura:component>
```

SEE ALSO:

Setting Attributes Inherited from a Super Component

Setting Attributes Inherited from an Interface

To set the value of an attribute inherited from an interface, redefine the attribute in the component and set its default value. Let's look at an example with the `c:myIntf` interface.

```
<!--c:myIntf-->
<aura:interface>
    <aura:attribute name="myBoolean" type="Boolean" default="true" />
</aura:interface>
```

This component implements the interface and sets `myBoolean` to `false`.

```
<!--c:myIntfImpl-->
<aura:component implements="c:myIntf">
    <aura:attribute name="myBoolean" type="Boolean" default="false" />

    <p>myBoolean: {!v.myBoolean}</p>
</aura:component>
```

Component Reference

Use out-of-the-box components for Lightning Experience, Salesforce mobile app, or for your Lightning apps.

The reference documentation is available in the Component Library at the following links.

- As an unauthenticated experience at developer.salesforce.com/docs/component-library
- As an authenticated experience at `https://<myDomain>.lightning.force.com/componentReference/suite.app`, where `<myDomain>` is the name of your custom Salesforce domain

These components belong to different namespaces, including:

aura
Provides components that are part of the framework's building blocks.

force
Provides components for field- and record-specific implementations.

forceChatter
Provides components for the Chatter feed.

forceCommunity
Provides components for Communities.

lightning

Provides components with Lightning Design System styling. For components in this namespace that are used in standalone Lightning apps, extend `force:slds` to implement Lightning Design System styling. In instances where there are matching `ui` and `lightning` namespace components, we recommend that you use the `lightning` namespace component. The `lightning` namespace components are optimized for common use cases. Event handling for `lightning` namespace components follows standard HTML practices and are simpler than that for the `ui` namespace components.

ui

Provides an older implementation of user interface components that don't match the look and feel of Lightning Experience and the Salesforce mobile app. Components in this namespace support multiple styling mechanism, and are usually more complex.

wave

Provides components for Analytics Home in Lightning

Interface Reference

Implement these platform interfaces to allow a component to be used in different contexts, or to enable your component to receive extra context data. A component can implement multiple interfaces. Some interfaces are intended to be implemented together, while others are mutually exclusive. Some interfaces have an effect only in Lightning Experience and the Salesforce app.

The reference documentation is available in the Component Library at the following links.

- As an unauthenticated experience at developer.salesforce.com/docs/component-library
- As an authenticated experience at `https://<myDomain>.lightning.force.com/componentReference/suite.app`, where `<myDomain>` is the name of your custom Salesforce domain

Interfaces belong to different namespaces, including:

clients

Provides interfaces that are specific to Lightning for Outlook or Lightning for Gmail.

flexipage

Provides interfaces that are specific to Lightning Pages and the Lightning App Builder.

force

Provides interfaces that are specific to Lightning Experience and the Salesforce app.

forceCommunity

Provides interfaces that are specific to Communities.

lightning

Provides interfaces that are specific to Lightning Experience, the Salesforce app, and Communities.

ltng

Provides events that are handled by Lightning Out.

Event Reference

Use out-of-the-box events to enable component interaction within Lightning Experience or the Salesforce app, or within your Lightning components. For example, these events enable your components to open a record create or edit page, or navigate to a record.

The reference documentation is available in the Component Library at the following links.

- As an unauthenticated experience at developer.salesforce.com/docs/component-library

- As an authenticated experience at `https://<myDomain>.lightning.force.com/componentReference/suite.app`, where `<myDomain>` is the name of your custom Salesforce domain

Events belong to different namespaces, including:

force
: Provides events that are handled by Lightning Experience and the Salesforce app.

forceChatter
: Provides events that are handled by Chatter publisher.

forceCommunity
: Provides events that are handled by Communities.

lightning
: Provides events that are handled by Lightning Experience, the Salesforce app, and Communities.

ltng
: Provides events that send the record ID or generic message to another component.

ui
: Provides events that are handled by the legacy `ui` components.

wave
: Provides events that are handled by Analytics.

If you fire one of these `force` or `lightning` events in your Lightning apps or components outside of the Salesforce app or Lightning Experience:

- You must handle the event by using the `<aura:handler>` tag in the handling component.
- Use the `<aura:registerEvent>` or `<aura:dependency>` tags to ensure that the event is sent to the client, when needed.

APPENDIX

CHAPTER 21 Aura Request Lifecycle

In this chapter ...

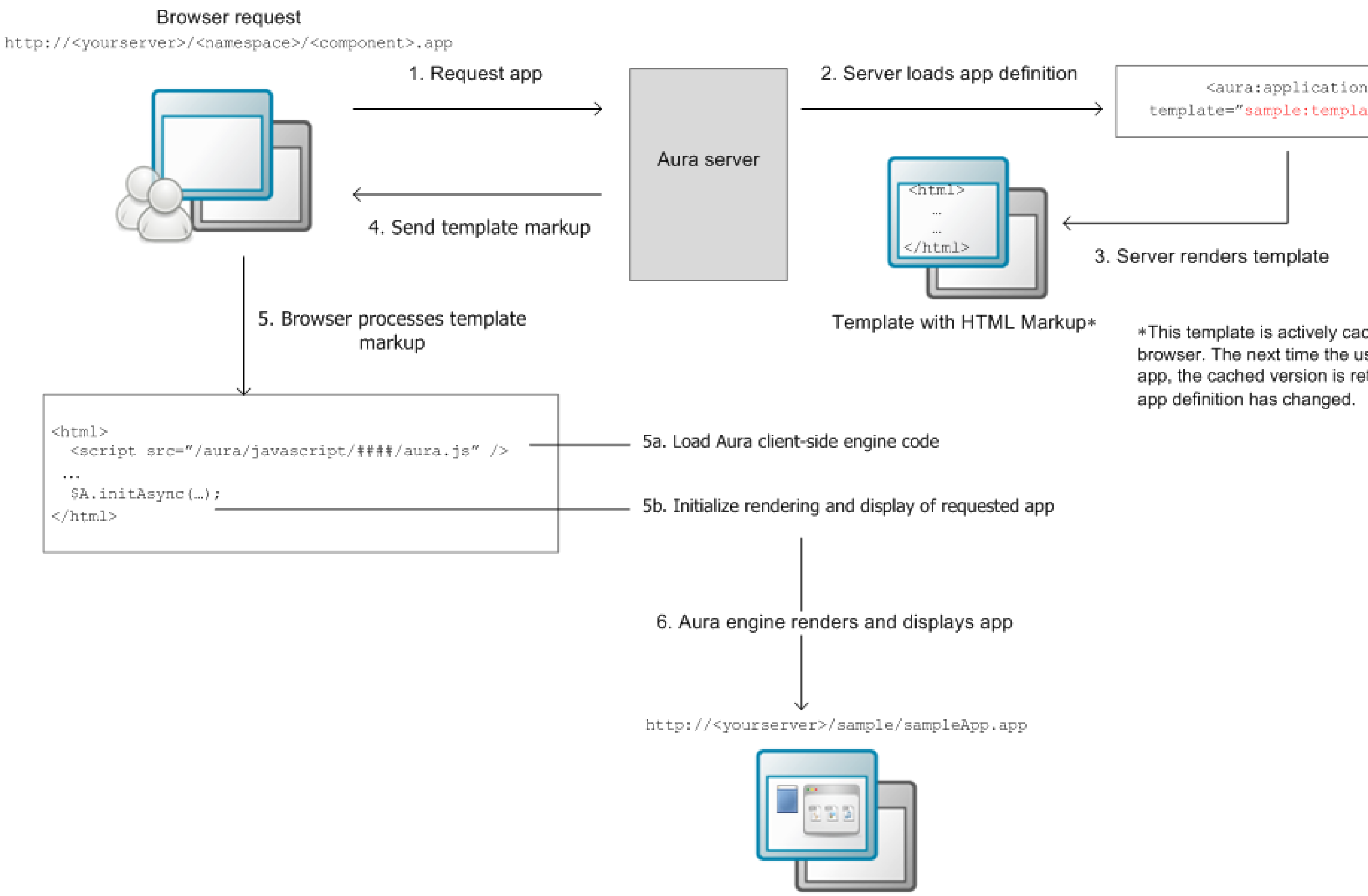
This section shows how Aura handles the initial request for an application, as well as a component request. You can use Aura without knowing these details but read on if you are curious about how things work under the covers.

Initial Application Request

When you make a request to load an application on a browser, Aura returns an HTTP response with a default template, denoted by the template attribute in the `.app` file. The template contains JavaScript tags that make requests to get your application data.

The browser renders the specified template and loads the Aura engine and the component definitions in the dependency tree of the app. The Aura engine renders the requested application. The Aura engine processes the application markup, and translates the component markup to HTML objects, returning the DOM elements that are rendered to the browser.

This diagram illustrates the component request lifecycle.



SEE ALSO:

Component Request Overview

Component Request Lifecycle

When a component is requested, Aura retrieves the relevant metadata and data from the server to construct the component. The framework uses the metadata and data to construct the component on the client, enabling the client to render the component.

IN THIS SECTION:

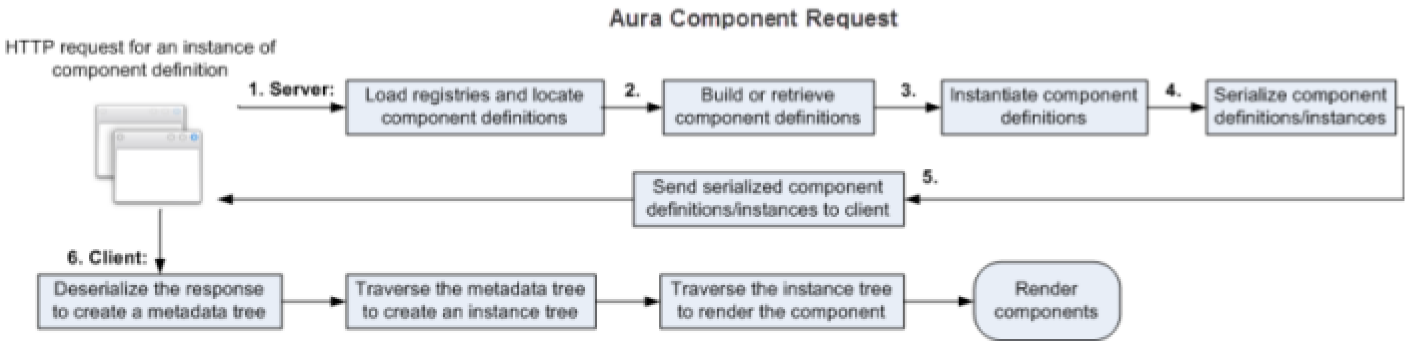
Component Request Overview

Aura performs initial construction of a component on the server. The client completes the initialization process and manages any rendering or rerendering.

Before we explore the component request process, it's important to understand these terms.

Term	Description
Definition	Each definition describes metadata for an element, such as a component, event, controller, or model. A large part of Aura is a registry of definitions for its various elements. A definition's metadata can include a name, location of origin, and descriptor (DefDescriptor, the primary key of the definition).
DefDescriptor	A DefDescriptor acts as a key for a definition in a registry. It's an Aura class that contains the metadata for any definition used in Aura, such as a component, action, or event. In the example of a model, it is a nicely parsed description of `model="java://myPackage.MyClass"` with methods to retrieve the language, class name, and package name. Rather than passing a more heavyweight definition around in code, Aura usually passes around a DefDescriptor instead. The qualified name for a DefDescriptor has a format of either `prefix://namespace:name` or `prefix://namespace.name`. For example, `js://ui.button`. • prefix: Defines the language, such as JavaScript or Java • namespace: Corresponds to the package name or XML namespace • name: Corresponds to the class name or local name
Instance	An instance represents the data for a component, event, or action. The component data is contained in its model and attributes.
Registry	Registries store metadata definitions. Some registries last for the duration of a request, while others are cached for the lifetime of the app server. They may be created during the request process and destroyed when the server completes the request. A master definition registry contains a list of registries for each Aura resource.

Let's see what happens when a client requests a component at the server via an HTTP request in the form `http://<yourServer>/namespace/<component>.cmp`.



Here's how a component request is processed on the server and client:

The server:

1. Loads registries and locates component definitions
2. Builds or retrieves component definitions
3. Instantiates component definitions
4. Serializes component definitions and instances
5. Sends serialized component definitions and instances to the client

The client:

1. Deserializes the response to create a metadata tree
2. Traverses the metadata tree to create an instance tree
3. Traverses the instance tree to render the component
4. Renders the component

SEE ALSO:

Server-Side Processing for Component Requests
Client-Side Processing for Component Requests

Server-Side Processing for Component Requests

A component lifecycle starts when the client sends an HTTP request to the server, which can be in the form `http://<yourServer>/<namespace>/<component>.cmp`. Attributes can be included in the query string, such as `http://<yourServer>/<namespace>/<component>.cmp?title=Component1`. If attributes are not specified, the defaults that are defined in the attribute definition are used.

For a component request, the server:

1. Load registries and locates component definitions.
2. Build or retrieves component definitions.
3. Instantiate component definitions.
4. Serialize component definitions and instances.
5. Send serialized component definitions and instances to the client.

1. Load registries and locate component definitions.

When the server receives an HTTP request, the Aura framework is loaded according to the specified mode. `AuraContextFilter` creates a `AuraContext`, which contains the mode denoted by the `aura.mode` parameter in the URL, such as in `http://<yourServer>/namespace/<component>.cmp?aura.mode=PROD`. Aura uses the default mode if the `aura.mode` parameter is not included in the query string.

The server receives and parses the request for an instance of a component definition (`ComponentDef`). If attributes are included, Aura converts them to strongly typed attributes for the component definition.

Next, the registries are loaded. Registries store metadata for Aura objects. They may be created during the request process and destroyed when the server completes the request.

A master definition registry (`MasterDefRegistry`) contains a list of registries (`DefRegistry`) that are used to load and cache definitions. A separate registry is used for each Aura object, such as actions, or controllers.

2. Build or retrieve component definitions.

This stage of the process retrieves the component's metadata, known as the `ComponentDef`.

After the relevant registries are identified, the server determines if the requested `ComponentDef` is already cached.

- If it's cached in a registry or found in other locations, the `ComponentDef` is returned and the component definition tree is updated to include the definition. The `ComponentDef` is cached, including its references to other `ComponentDefs`, attributes, events, controller, and resources, such as CSS styles.
- If the `ComponentDef` is not cached, the server locates and parses the source code to construct the `ComponentDef`. The server also identifies the language and definition type of the `ComponentDef`.

Any dependencies on other definitions are also determined. Dependencies may include definitions for interfaces, controllers, actions, and models. A `DefRegistry` that doesn't contain the `ComponentDef` passes the request to a `DefFactory`, which builds the definition.

Each component definition in the tree is parsed iteratively. The process is completed when the `ComponentDef` tree doesn't contain any unparsed `ComponentDefs`.

3. Instantiate component definitions.

Once the server completes the component definition process, it can create a component instance. To start this instantiation, the `ComponentDef` (a root definition) is retrieved along with any attribute definitions and references to other components. The next steps are:

- **Determine component definition type**: Aura determines whether the root component definition is abstract or concrete.
- **Create component instances**:
  - **Abstract**: Aura can instantiate abstract component definitions using a provider to determine the concrete component to use at runtime.
  - **Concrete**: Aura constructs a component instance and any properties associated with it, along with its super component. Attribute values of the component definitions are loaded, and can consist of other component definitions, which are instantiated recursively.
- **Create model instances**: After the super component definition is instantiated, Aura creates any associated component model that hasn't been instantiated.
- **Create attribute instances**: Aura instantiates all remaining attributes. If the attribute refers to an uninstantiated component definition, the latter is instantiated. Non-component attribute values may come from a client request as a literal or expression, which can be derived from a super component definition, a model, or other component definitions. Expressions can be resolved on the client side to allow data to be refreshed dynamically.

The instantiation process terminates when the component and all its child nodes have been instantiated. Note that controllers are not instantiated since they are static and don't have any state.

4. Serialize component definition and instances.

Aura enables dynamic rendering on the client side through a JSON serialization process, which begins after instantiation completes. Aura serializes:

- The component instance tree
- Data for the component instance tree
- Metadata for the component instance tree

When the current object has been serialized but it's not the root object corresponding to the requested component, its parent objects are serialized recursively.

5. Send serialized component definitions and instances to client.

The server sends the serialized component definitions and instances to the client. Definitions are cached but the instance data is not cached.

The definitions are transmitted in the following format:

```
{"descriptor":"markup://aura:component",
"rendererDef":{ "serRefId":2},
"attributeDefs":[{ "serId":20,
                    "value":{ "descriptor":"body",
                    "typeDefDescriptor":"aura://Aura.Component[]",
                    "required":false} } ],
                    "interfaces":["markup://aura:rootComponent"],
                    "isAbstract":true}
```

The component instance tree is transmitted in the following format:

```
$A.initAsync({"context":{"mode":"DEV","app":"auradocs:sample",
       "requestedLocales":["en_US","en"]},
       "deftype":"APPLICATION",
       "descriptor":"markup://auradocs:sample",
       "host":"",
       "lastmod":1323498293847});
```

SEE ALSO:

Server-Side Runtime Binding of Components

Initial Application Request

Component Request Glossary

Client-Side Processing for Component Requests

After the server processes the request, it returns the component definitions (metadata for the all required components) and instance tree (data) in JSON format.

The client performs these tasks:

1. Deserialize the response to create a metadata tree.

2. Traverse the metadata tree to create an instance tree.
3. Traverse the instance tree to render the component.
4. Render the components.

1. Deserialize the response to create a metadata tree.

The JSON representation of the component definition is deserialized to create a metadata structure (JavaScript objects or maps). By default, any Map, Array, Number, Boolean, String or nulls are supported for serialization and deserialization. Other objects can provide custom serialization by implementing the `JsonSerializable` interface.

2. Traverse the metadata tree to create an instance tree.

The client traverses the JavaScript tree to initialize objects from the deserialized tree. The tree can contain:

- Definition: The client initializes the definition.
- Descriptor only: The client knows that definition has been pre-loaded and cached.

As part of component initialization, client-side framework code are cached alongside your JavaScript code and CSS.

3. Traverse the instance tree to render the component.

After component initialization, the client traverses the instance tree to render the component instance. The reference IDs are used to recreate the component references, which can point to a `ComponentDef`, a model, or a controller.

4. Render the components.

The client locates the renderer definition in the component bundle, or uses the default renderer method to render the component and any sub-components recursively. This adds the components to the DOM. For more information on the rendering lifecycle, see Events Fired During the Rendering Lifecycle on page 139.

SEE ALSO:

Server-Side Rendering to the DOM
Initial Application Request
Component Request Glossary

Component Request Glossary

This glossary explains terms related to Aura definitions and registries.

Definition-related Term	Example	Description
Definition	`aura:component`	Each definition describes metadata for an object, such as a component, event, controller, or model. A large part of Aura is a registry of definitions for its various objects.

Definition-related Term	Example	Description
		A definition's metadata can include a name, location of origin, and descriptor (`DefDescriptor`, the primary key of the definition). A component definition can be used by other component definitions and can extend another component definition.

Root Definition	`ComponentDef`
	`InterfaceDef`
	`EventDef`
		Top-level definition. Markup language for a root definition can include a pointer to another definition, and references to the descriptors of associate definitions.

Associate Definition	`ControllerDef`
	`ModelDef`
	`ProviderDef`
	`RendererDef`
	`StyleDef`
	`TestSuiteDef`
		Associate definitions represent objects that are associated with a root definition. An instance of an associate definition can be shared by multiple root definitions. Associate definitions have their own factories, parsers, and caching layers.

Subdefinition	`AttributeDef`
	`RegisterEventDef`
	`ActionDef`
	`TestCaseDef`
	`ValueDef`
		Subdefinitions can be used to define root definitions or associate definitions. They are stored directly on their parent definitions.
		For example, a `ComponentDef` can include multiple `AttributeDef` objects, and a `ControllerDef` can include multiple `ActionDef` objects.

Definition Reference	`DefRef`
	`ComponentDefRef`
	`AttributeDefRef`
		A subdefinition that points to another definition. At runtime, it can be turned into an instance of the definition to which it points.
		For example, when a component is instantiated, the component definition can include attribute definition references for each component attribute. The attribute definition reference points to the underlying attribute definition.

Provider		For abstract definition types. A provider determines the concrete `ComponentDef` to instantiate for each abstract `ComponentDef`. A provider enables an abstract component definition to be used directly in markup.

Registry-related Terms	Example	Description
Master Definition Registry	`MasterDefRegistry`	`MasterDefRegistry` is a top-level `DefRegistry` that lives for the duration of a request. It is a thin redirector to various

Registry-related Terms	Example	Description
		long-lived definition registries that load and cache definitions.
Definition Registry	`DefRegistry`	A `DefRegistry` loads and caches a list of definitions, such as `ActionDef`, `ApplicationDef`, `ComponentDef`, or `ControllerDef`. A separate registry is used for all Aura objects. If the definition is not found, the request is passed to `DefFactory`, an interface that builds the definition.
Definition Descriptor	`DefDescriptor`	A `DefDescriptor` acts as a key for a definition in a registry. It's a class that contains the metadata for any definition used in Aura, such as a component, action, or event. In the example of a model, it is a nicely parsed description of `model="java://myPackage.MyClass"` with methods to retrieve the language, class name, and package name. Rather than passing a more heavyweight definition around in code, Aura usually passes around a `DefDescriptor` instead. The qualified name for a `DefDescriptor` has the format `prefix://namespace:name`. • prefix: Defines the language, such as JavaScript or Java • namespace: Corresponds to the package name or XML namespace • name: Corresponds to the class name or local name

INDEX