Mobile App Development

Stateless vs Stateful Widget

Stateless Widget

- Immutable
- Build once
- No internal state to manage
- Example: `Text`, `Icon`, `RaisedButton`
- Use when UI does not change dynamically

Stateful Widget

- Mutable
- Can rebuild multiple times
- Maintains internal state
- Example: `Checkbox`, `TextField`, `Form`
- Use when UI changes dynamically
- Requires `State` class to manage state

Flutter Widget Tree

From Widget to Element

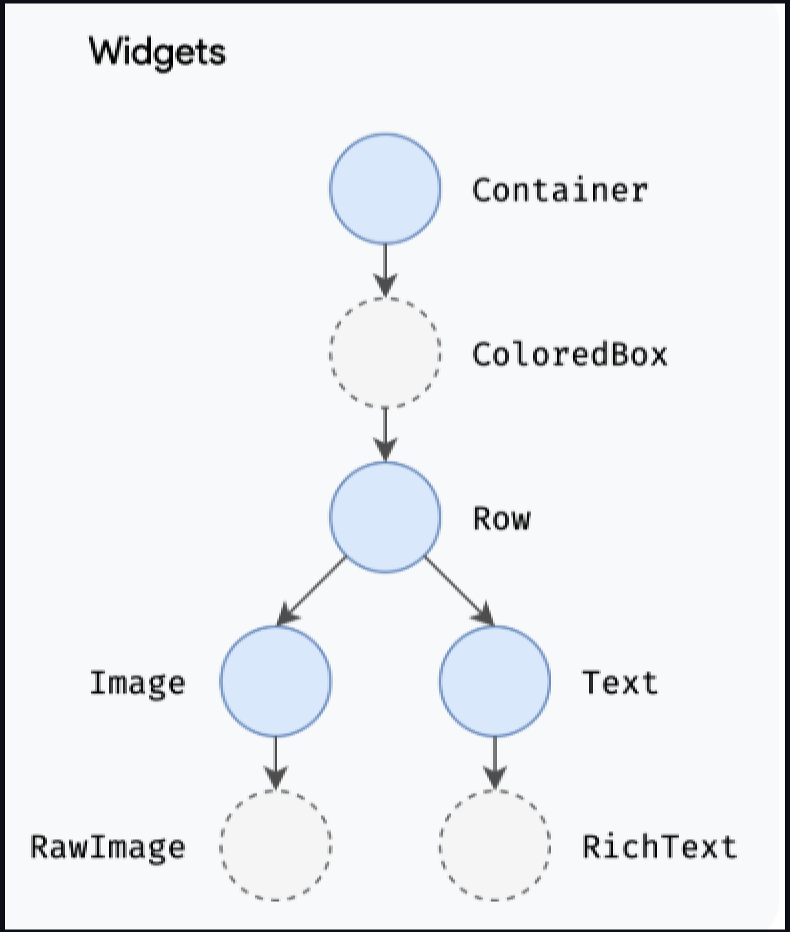
Widget Tree

- Widgets are immutable descriptions of part of a user interface.
- The widget tree is a hierarchical structure of widgets that defines the layout and behavior of the UI.
- Widget are created from `build()` methods.

Widget Tree

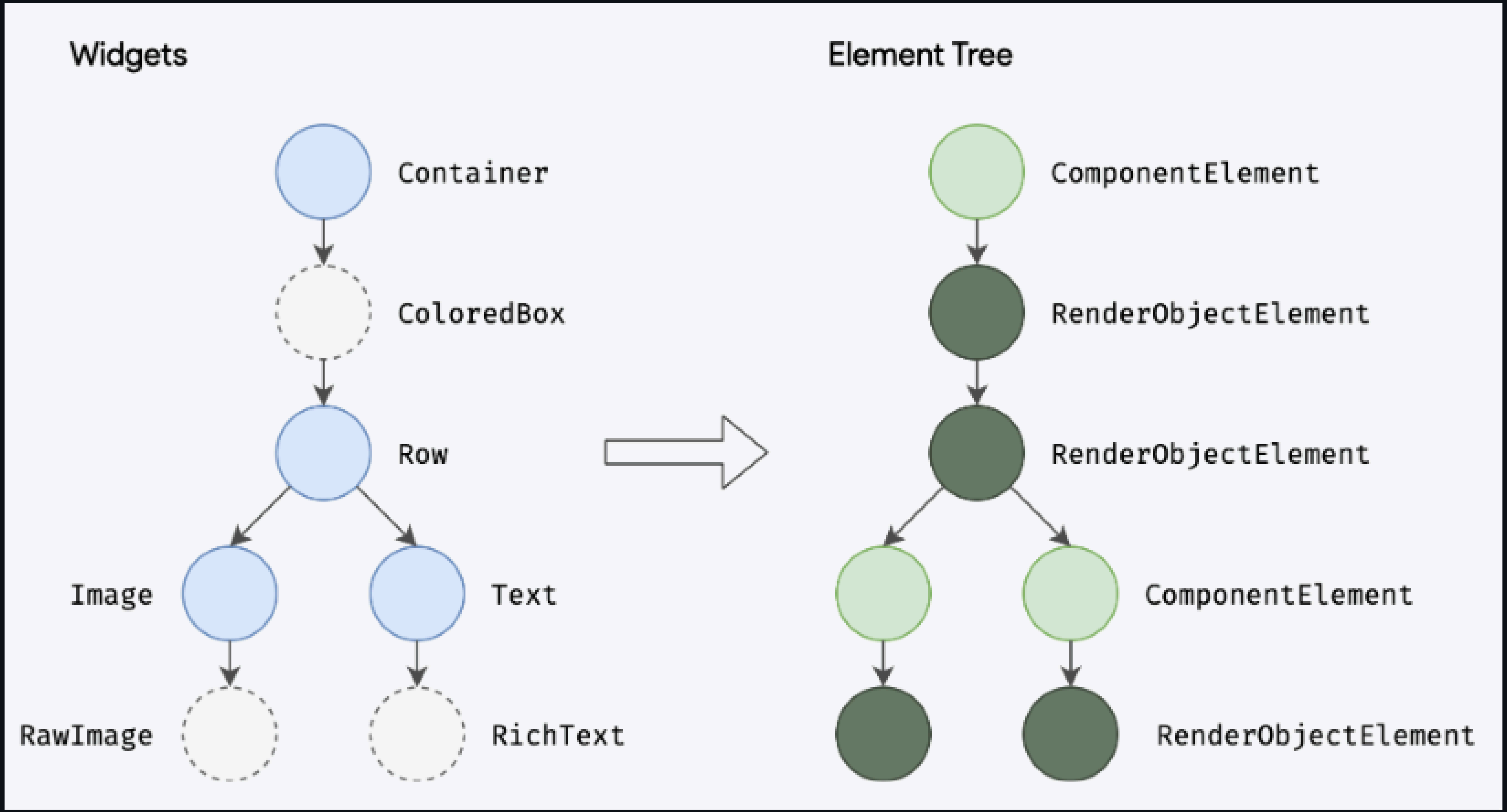
```
Container(
  color: Colors.blue,
  child: Row(
    children: [
      Image.network('https://www.example.com/1.png'),
      const Text('A'),
    ],
  ),
);
```

- Note `Container` class is a `StatelessWidget` which has `build()` method that returns other widgets.


Widgets
Container
ColoredBox
Row
Image
Text
RawImage
RichText

Element Tree

- Elements are the instantiation of widgets at runtime.
- The element tree is a hierarchical structure of elements that represents the current state of the UI.
- Elements are created from widgets during the build process.
    - Using `createElement()` method of the widget.

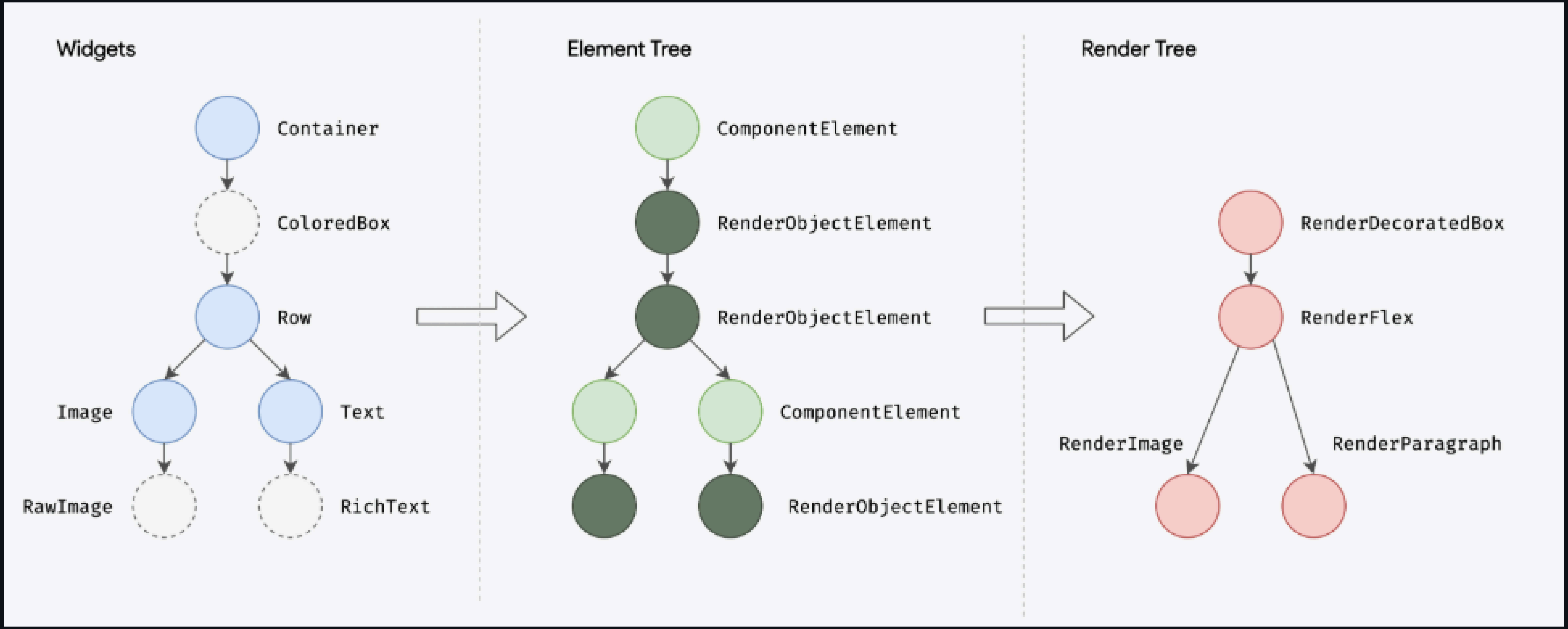


`ComponentElement`: a host for other elements.

`RenderObjectElement`: an element that participates in the layout or paint phases.

Render Tree

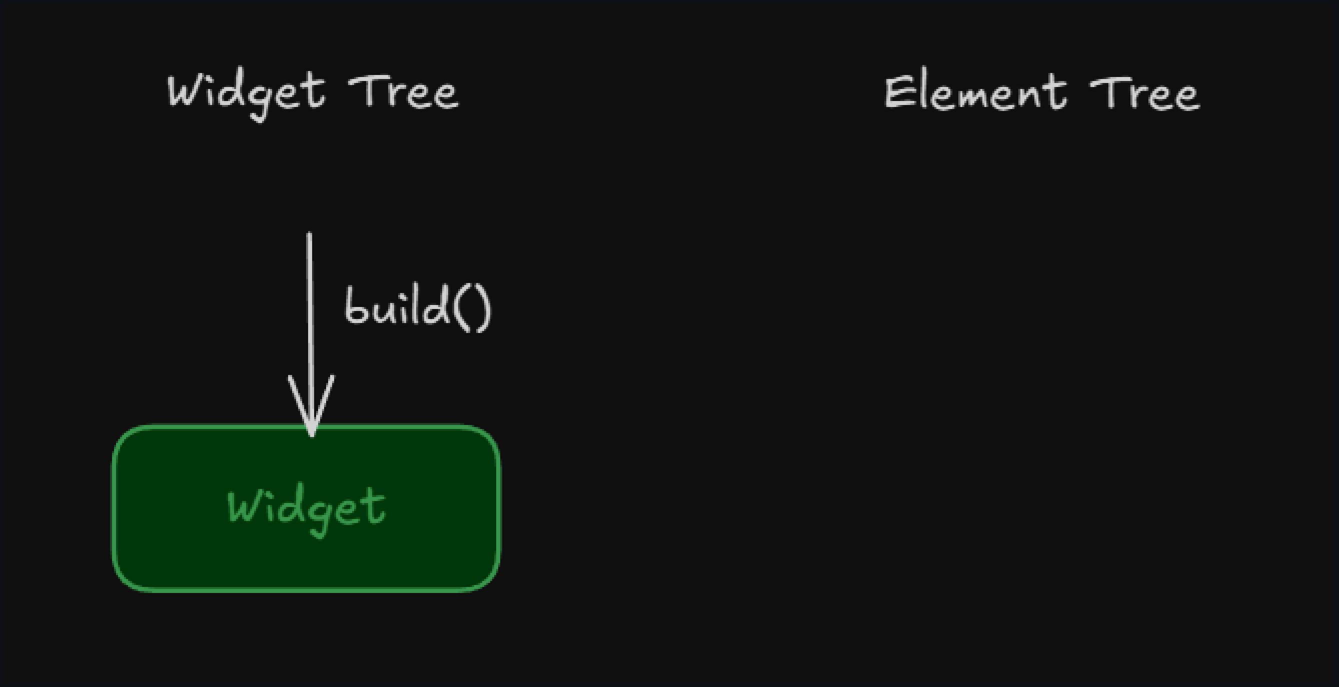
- Render objects are responsible for layout, painting, and hit testing.
- The render tree is a hierarchical structure of render objects that defines how the UI is drawn on the screen.
- Render objects are created from elements during the build process.
  - Using `createRenderObject()` method of the element.


Widgets
Container
ColoredBox
Row
Image
Text
RawImage
RichText
Element Tree
ComponentElement
RenderObjectElement
RenderObjectElement
ComponentElement
RenderObjectElement
Render Tree
RenderDecoratedBox
RenderFlex
RenderImage
RenderParagraph

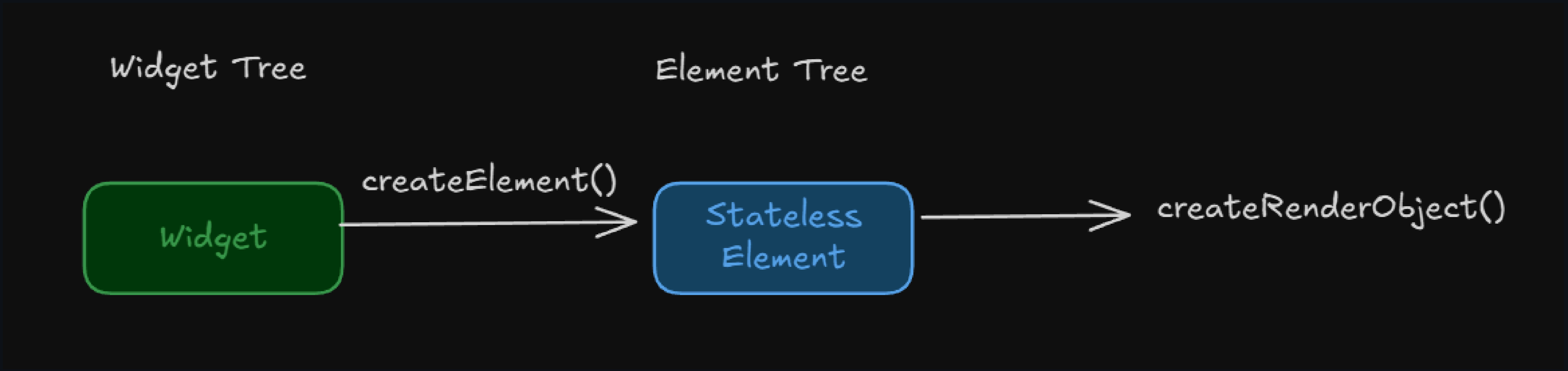
Summary

- **Widget tree**: Immutable descriptions of the UI.
- **Element tree**: Runtime instances of widgets.
- **Render tree**: Objects responsible for layout and painting.

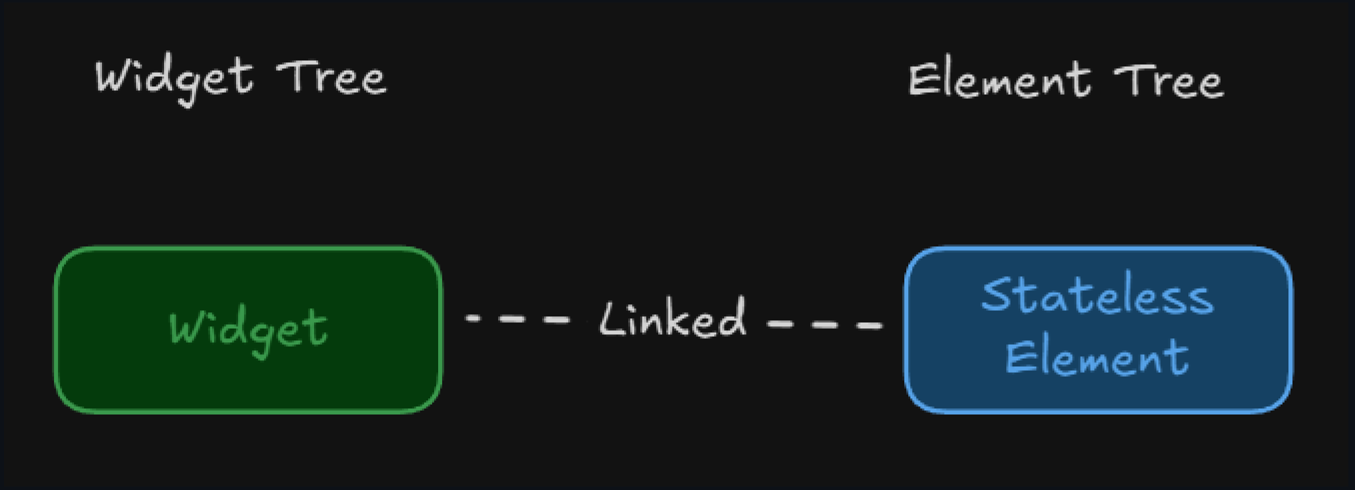
Flutter Stateless Widget Lifecycle



A widget is created through `build()` method.

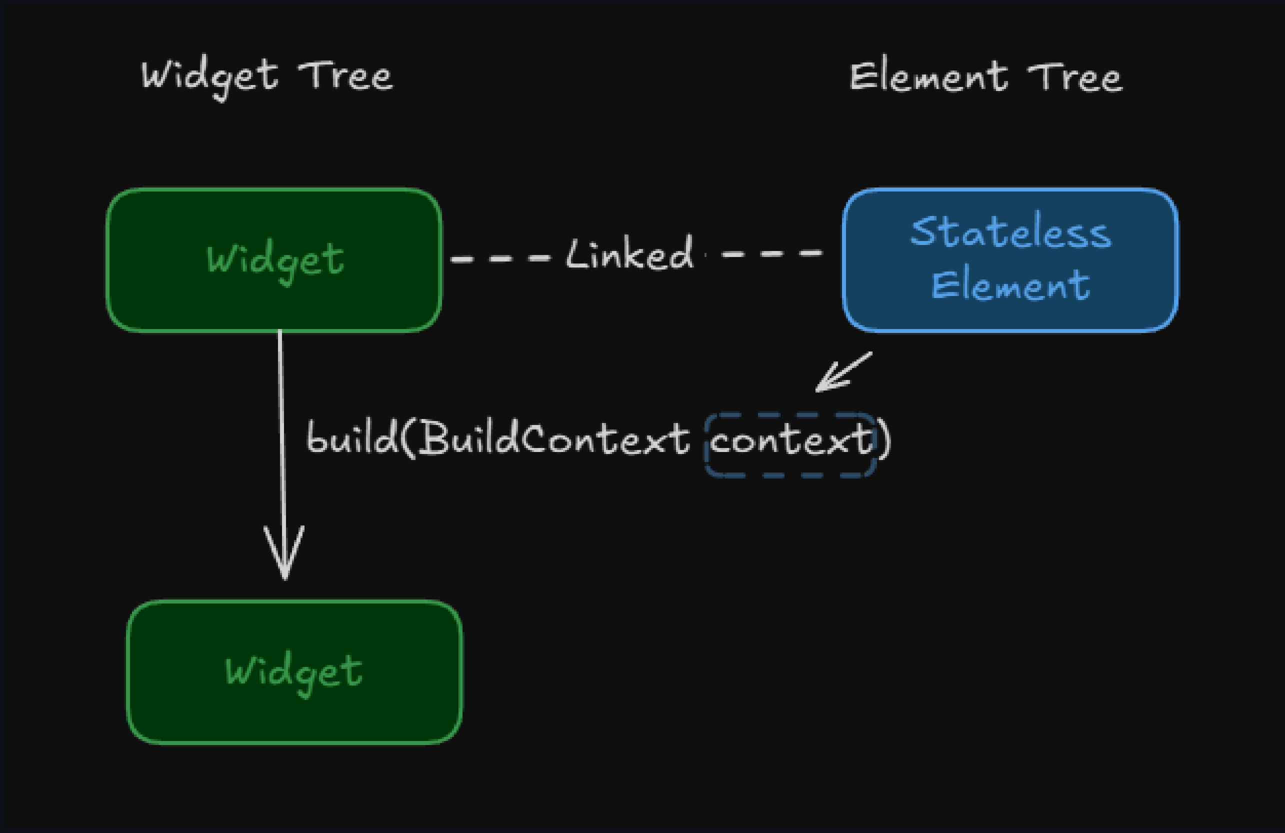


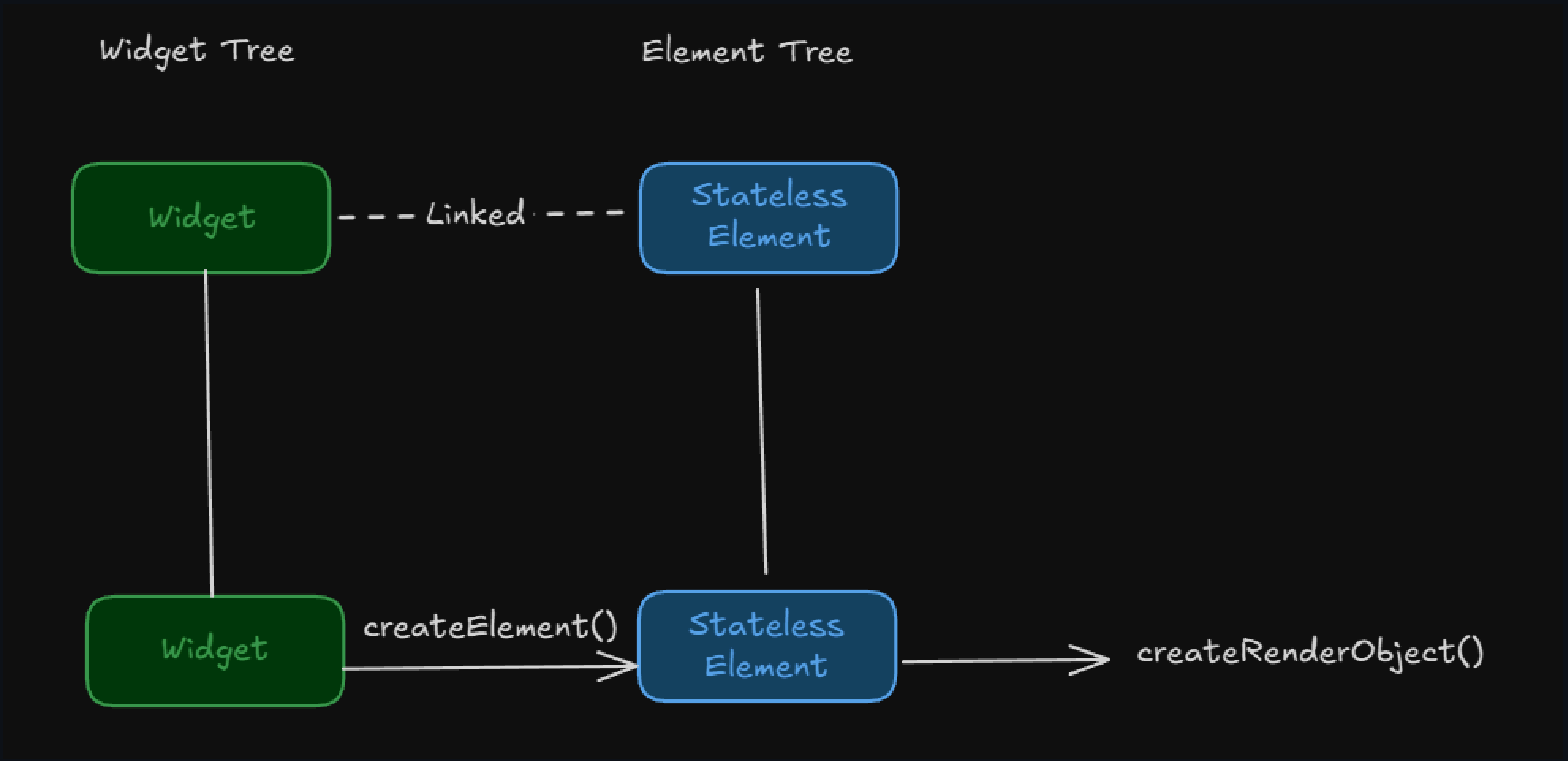
- The framework calls the `createElement()` method to create an element for the widget.
  - The element called the `mount()` method to attach itself to the render tree.
- The element calls the `createRenderObject()` method to create a render object for the element.



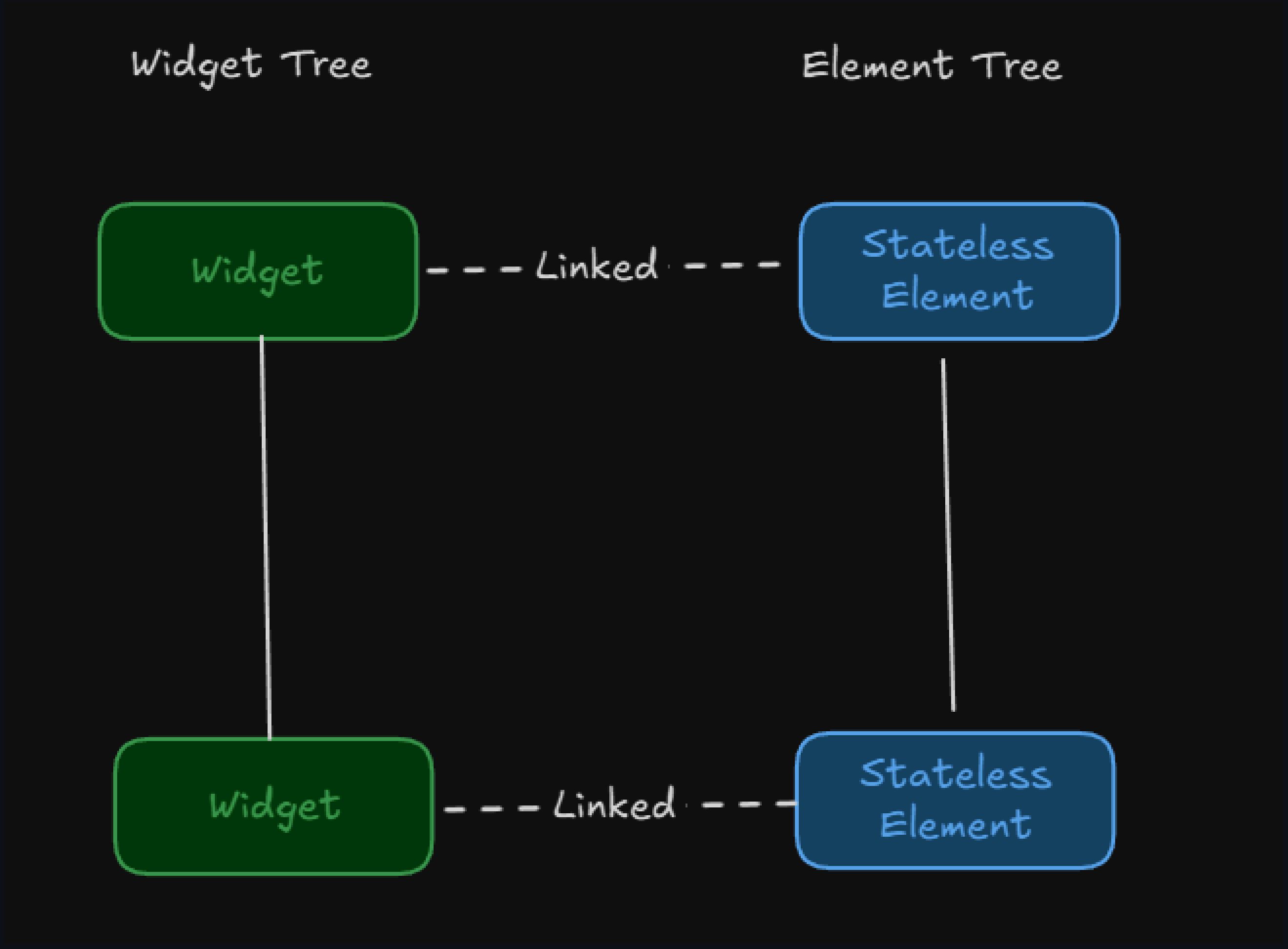
The element maintains a link to the corresponding widget under the instance attribute called `widget`.

- The framework calls the `build()` method of the widget to create child widgets.
- The element is injected into the `build()` method as the `BuildContext` parameter.
  - A new widget is created.





The process continues recursively for child widgets.



The process continues recursively for child widgets.

Rebuild of Stateless Widget

- Parent widget rebuilds and creates a new instance of the stateless widget.
- The framework calls the `update()` method of the element to update the element with the new widget.
- The element calls the `updateRenderObject()` method to update the render object if necessary.
- The element calls the `build()` method of the new widget to create child widgets.

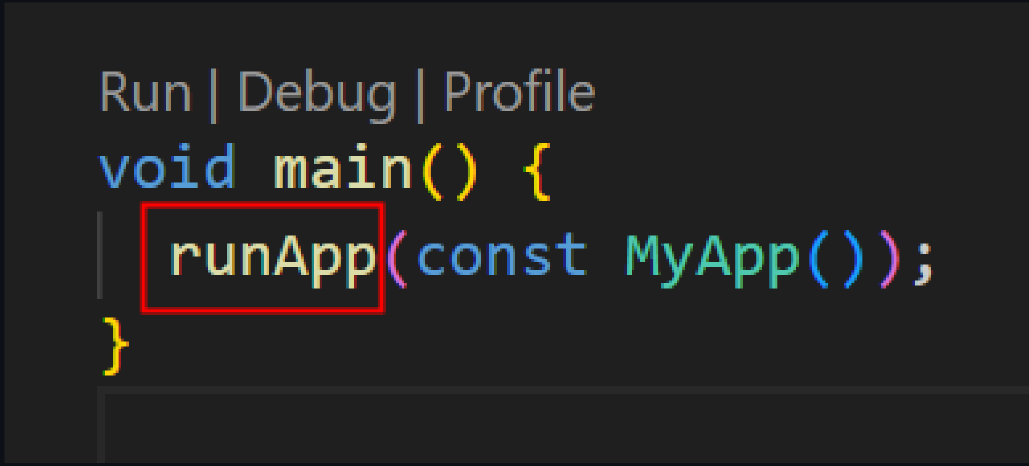
> Notice that the element is reused; it is not recreated.

Question

- If the widget is built from the parent's `build()` method, where is the first build method called?

Answer

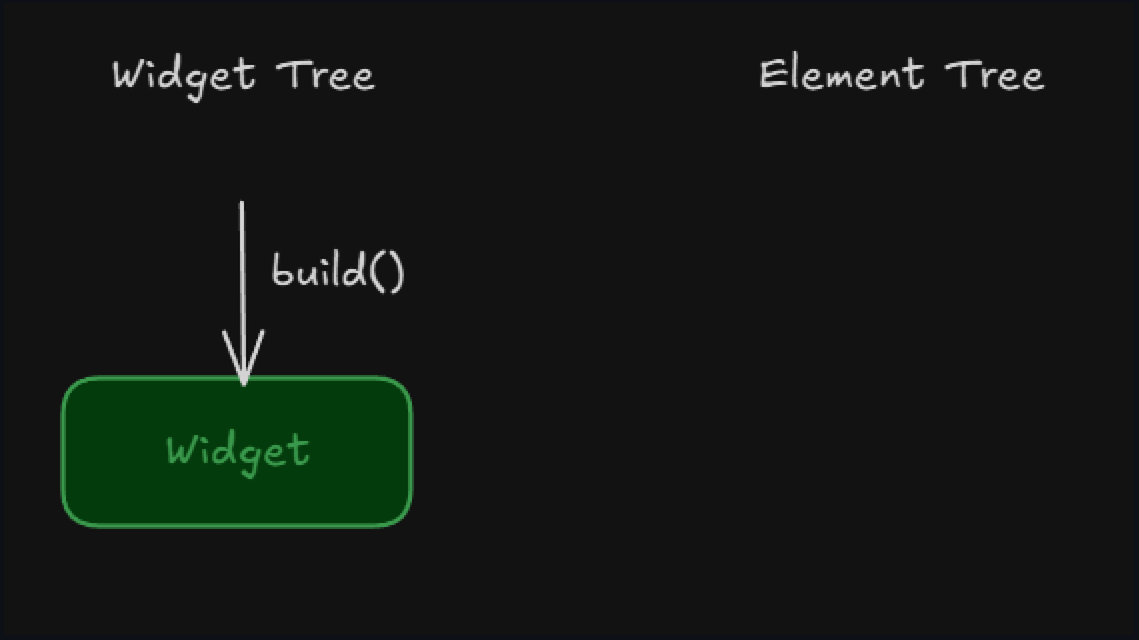
The first `build()` method is called from the `runApp()` function, which initializes the widget tree.



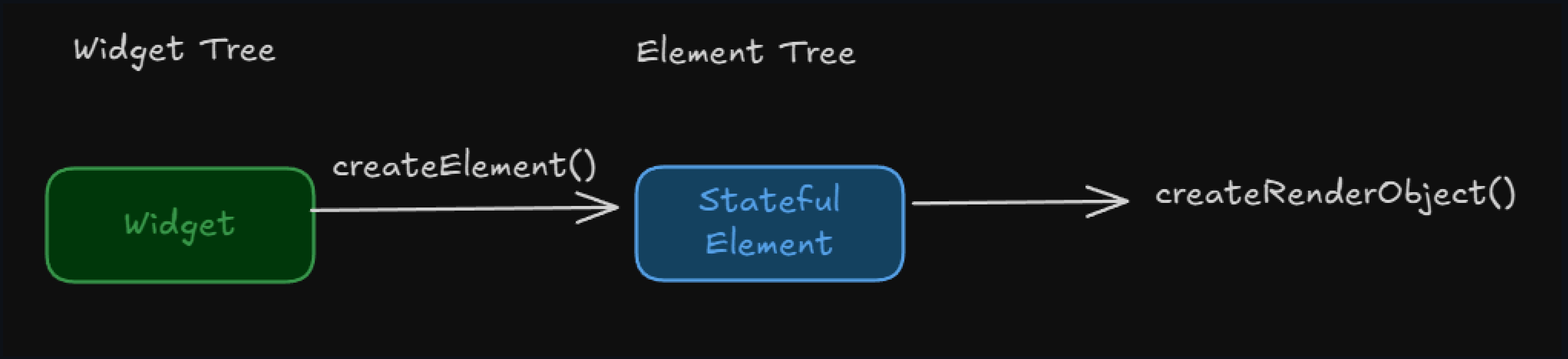
```
void main() {
  runApp(const MyApp());
}
```

Lifecycle of Stateful Widget

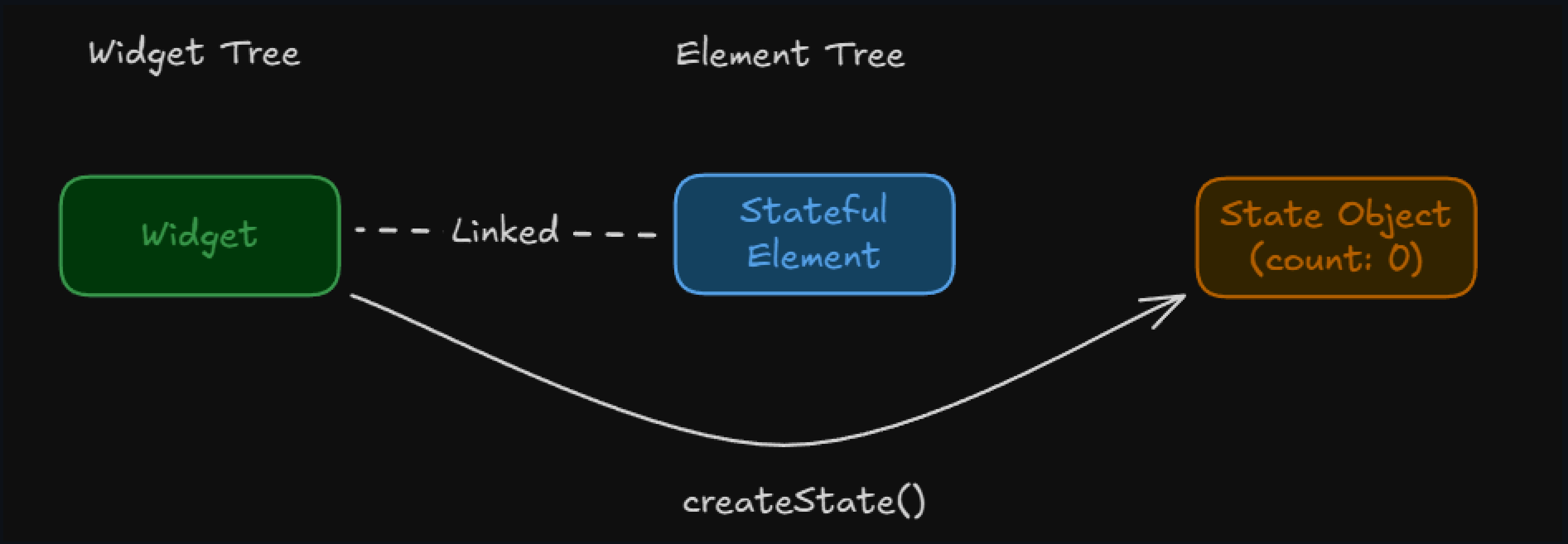
- Similar to stateless widget but with additional state management.
- The state is managed by a separate `State` class.
- The `State` class has its own lifecycle methods, such as `initState()` and `setState()`.



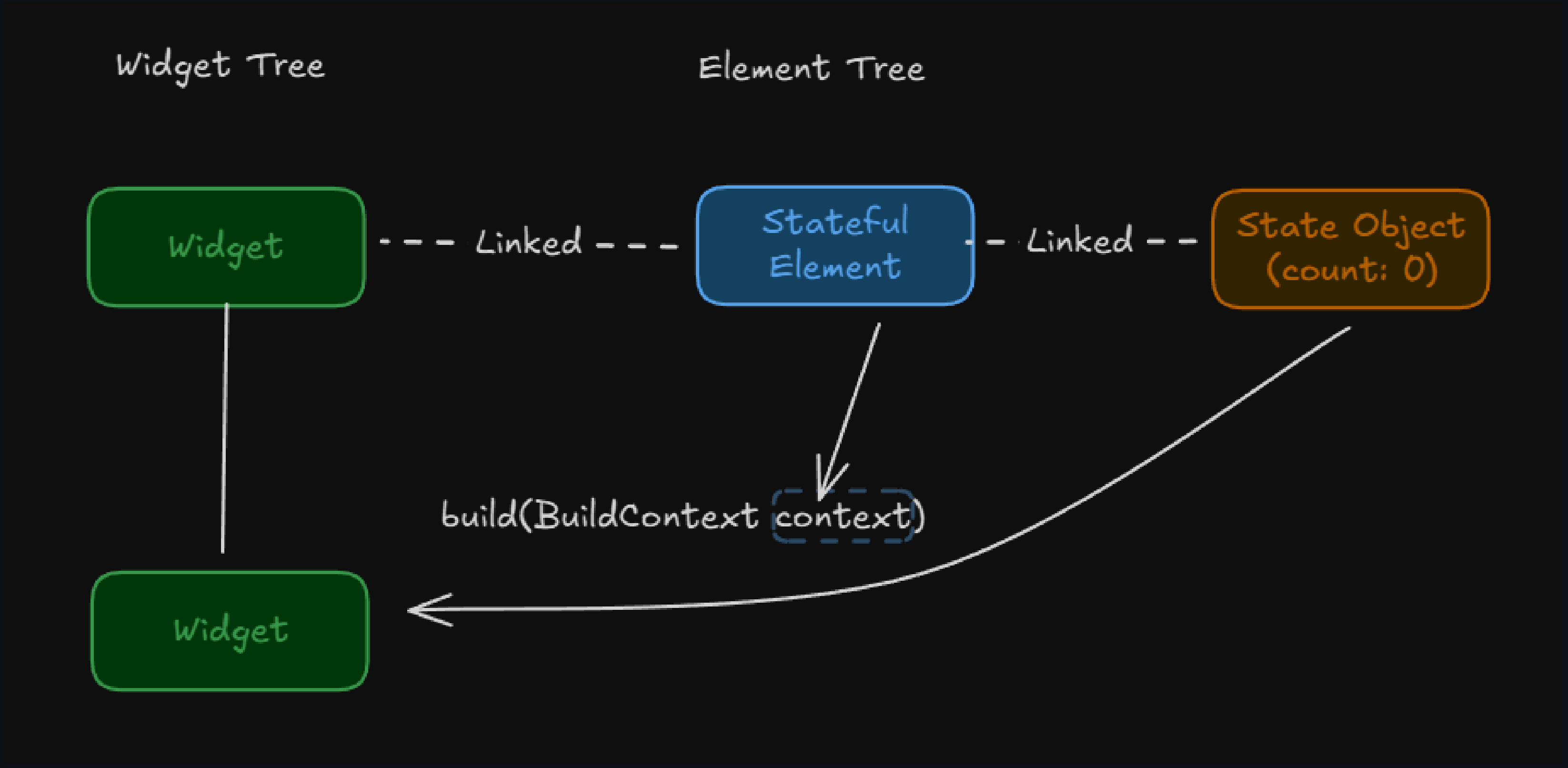
A widget is created through `build()` method.



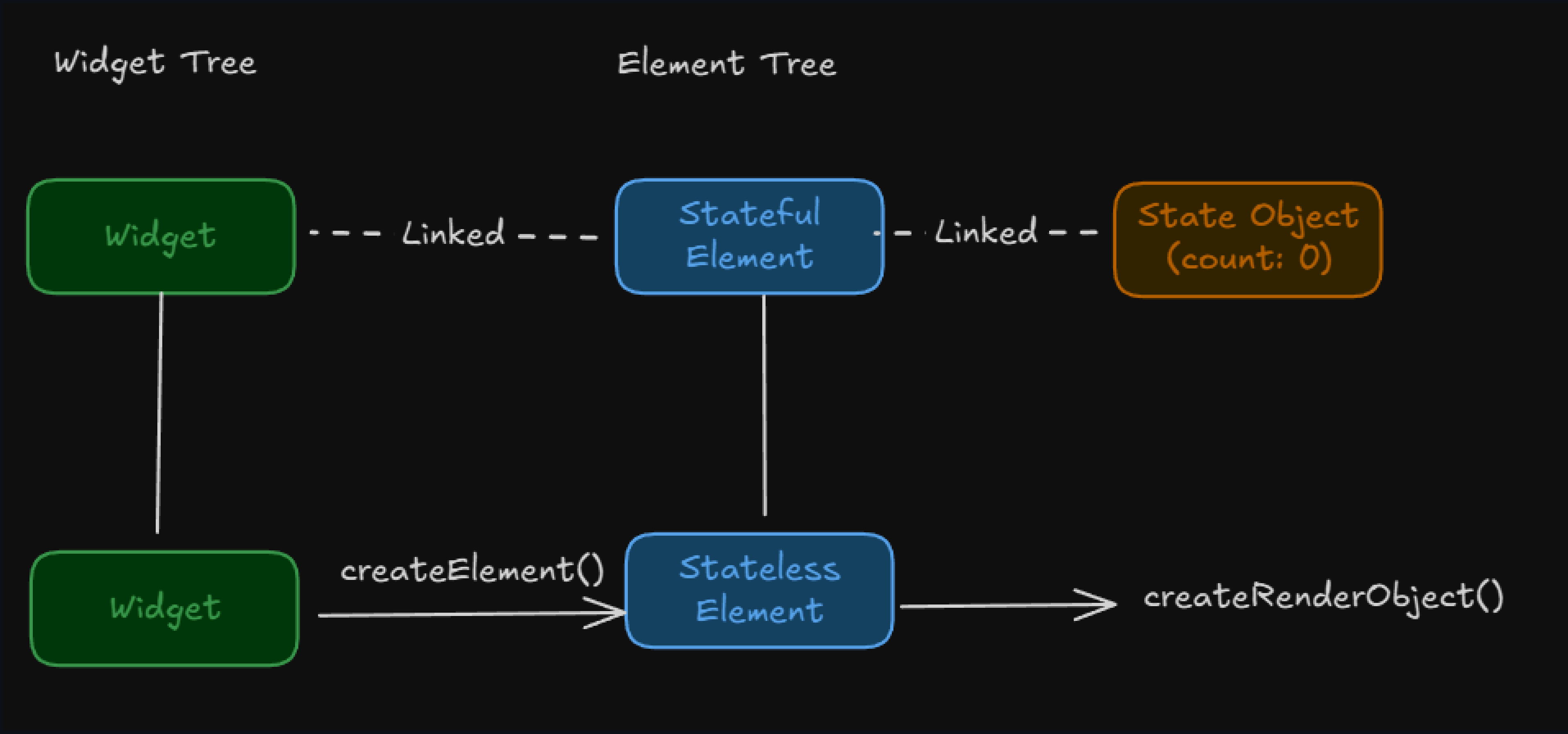
Element and render object are created similarly to stateless widget.



Here, the framework creates a `State` object for the stateful widget by calling the `createState()` method.



- The framework calls the build method of the state object to create child widgets.
- The element is again injected into the `build()` method.



The process continues recursively for child widgets.

What happens when `setState()` is called?

- The `setState()` method notifies the framework that the internal state of the widget has changed.
- The framework schedules a rebuild of the widget by calling the `build()` method of the state object.
- The element and render object are updated similarly to stateless widget rebuild.

> Notice that the element and state object are reused; they are not recreated. This maintains the state across rebuilds.

Key

- Keys are used to preserve the state of widgets when they are moved in the widget tree.
- Keys are especially important for stateful widgets to ensure that the correct state is associated with the correct widget.

Types of Keys

- `ValueKey` : used to identify widgets based on a specific value.
- `UniqueKey` : generates a unique key for each widget instance.
- `ObjectKey` : uses the identity of an object to identify the widget.
- `GlobalKey` : used to access a widget's state from outside its own context.

Resources

- Flutter Widget 101
- How flutter renders widgets
- Beginning Flutter