eclipseCON 2006

Best Practices for Programming Eclipse and OSGi

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Introduction

- During the Eclipse 3.0 and OSGi R4 development cycles, OSGi and Eclipse began to influence each others work
  - Eclipse 3.0 adopted the OSGi framework as the “footing” of the Eclipse platform
  - OSGi R4 incorporated features to support important Eclipse use cases
- This led to the OSGi R4 Framework specification of which Eclipse Equinox is an implementation
  - The Equinox code is currently being used by OSGi as the framework reference implementation for R4

Overview

- As a result of the incorporation of the OSGi framework into Eclipse, there are several additional capabilities now available to Eclipse plug-in writers that should be considered
- Today we will look at two areas
  - Modularity – Techniques for sharing classes and resources between bundles (aka. plug-in)
  - Collaboration – Techniques for inter bundle collaboration (which build upon class sharing)

Modularity

- "(Desirable) property of a system, such that individual components can be examined, modified and maintained independently of the remainder of the system. Objective is that changes in one part of a system should not lead to unexpected behavior in other parts."
  www.maths.bath.ac.uk/~jap/MATH0015/glossary.html
- We need to be able to share classes and resource between bundles (modules) while supporting a proper level of modularity
- Eclipse and OSGi offers two main ways of sharing
  - Require-Bundle
  - Import-Package

Require-Bundle

- Mechanism for a bundle to gain access to all the packages exported by another bundle – “bulk import”
- Advantages
  - Can be used for non-code dependencies: e.g. Help
  - Convenient shorthand for multiple imports
  - Joins split packages
- Disadvantages
  - Tight coupling – can be brittle since it requires the presence of a specific bundle
  - Split packages – Completeness, ordering, performance
  - Package shadowing
  - Unexpected signature changes

Import-Package

- Mechanism for a bundle to import specific packages
- Advantages
  - Loose coupling – implementation independence
  - Arbitrary attributes allow sophisticated export matching
  - No issues with package splitting or shadowing – whole package
- Disadvantages
  - More metadata to be created and maintained – each imported package must be declared
  - Only useful for code (and resource) dependencies
  - Can’t be used for split packages

Best Practices: Modularity

- In general, Import-Package is recommended
  - PDE (or other tools) can help with metadata management for packages used
  - Loosest coupling
    - More opportunities for resolver to successfully resolve
  - Provides more information to management system
- Require-Bundle used for complex scenarios
  - Refactoring bundles which results in splitting a package across more than one bundle
  - Have dependencies on a specific bundle and version
    - This could still be done with Import-Package
  - Also is a simple place to start when first modularizing legacy code
- To some degree, the choice is a trade off that you must make
  - Simplicity vs. flexibility

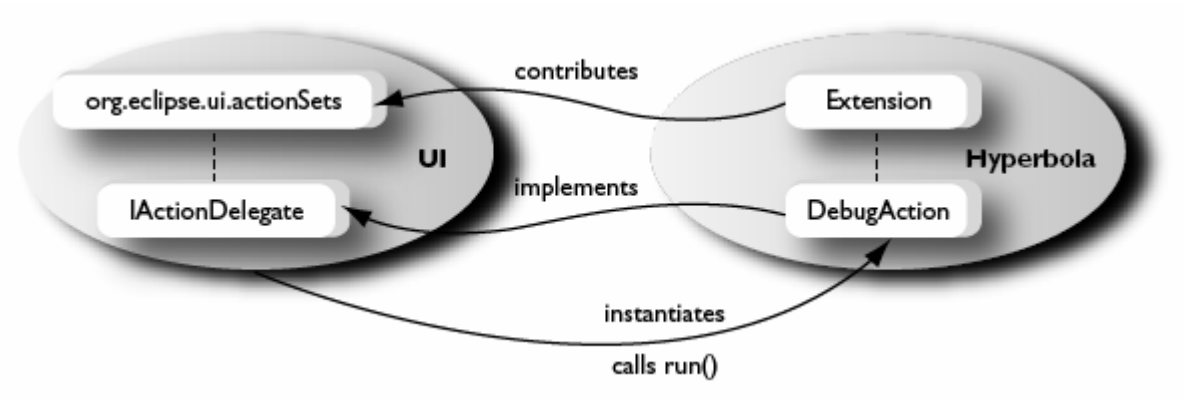
Collaboration

- Modularization is powerful
  - Decouples elements
  - More flexible configurations
  - Dynamic behavior
- Decoupled components need a way of interacting and cooperating
  - Our resolved bundles need to collaborate
- Eclipse includes three mechanisms for inter bundle collaboration
  - Extension registry
  - Service registry
  - Declarative Services – builds upon the service registry

Extension Registry

- *Extension Registry* : declarative relationships between plug-ins
- *Extension Point* : plug-ins open themselves for configuration/extension
- *Extension* : plug-in extends another by contributing an extension

"Plug-ins can contribute *actionSets* extensions that define actions with an id, a label, an icon, and a class that implements the interface *IActionDelegate*. The UI will present that label and icon to the user, and when the user clicks on the item, the UI will instantiate the given action class, cast it to *IActionDelegate*, and call its *run()* method."



Extension Registry

- The extension registry provides a per extension point list of contributed extensions
  - Aggregates all the extensions for the extension point
  - Provides a “private context” for the extension point and its extensions
    - Only the extension point will call the extension
- Tightly coupled model
  - Each extension is bound to a specific extension point
  - Extension point are no longer bound to specific bundles
- Declarative – plugin.xml
- Lazy loading of extension class
  - Metadata enables registration and attribute interrogation
- Life cycle scoped to resolved state of bundle
- Lifecycle is highly dynamic
  - Extension may be published or unpublished at any time (after bundle resolved)
  - Lifecycle event notifications
- No security to control
  - Which bundle can declare an extension point
  - Which bundle can contribute an extension

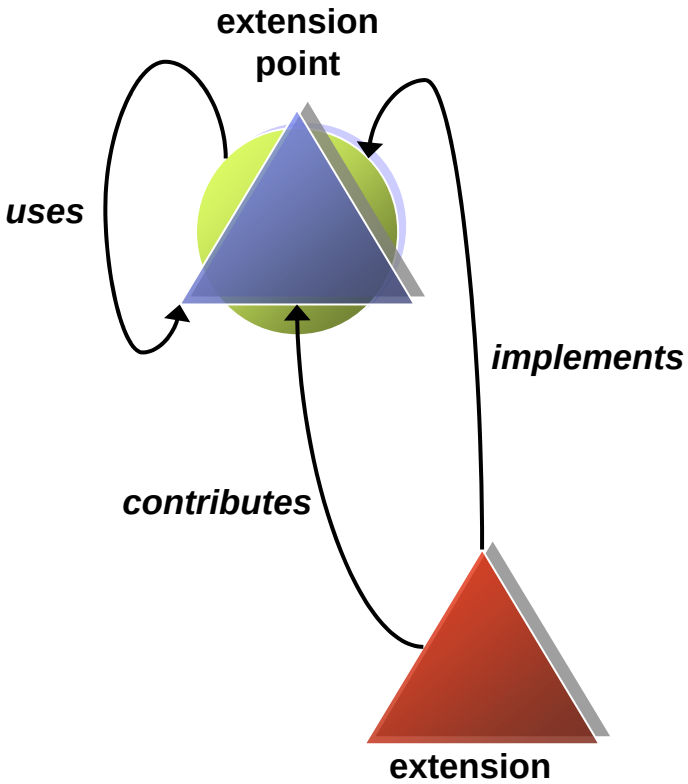
Service Registry

- The service registry is a publish/find/bind model
- Public context
  - Single service registry (within a framework instance)
- Loosely coupled model
  - Any bundle can bind to a service
- API based – non declarative
  - Service can be published with key/value pair metadata
- Eager loading of service class
  - Service object is published
- Life cycle scoped to started state of bundle
- Lifecycle is highly dynamic
  - Service may be published or unpublished at any time (after bundle started)
  - Lifecycle event notifications
- Permissions to control whether a bundle can publish, find or bind to a service

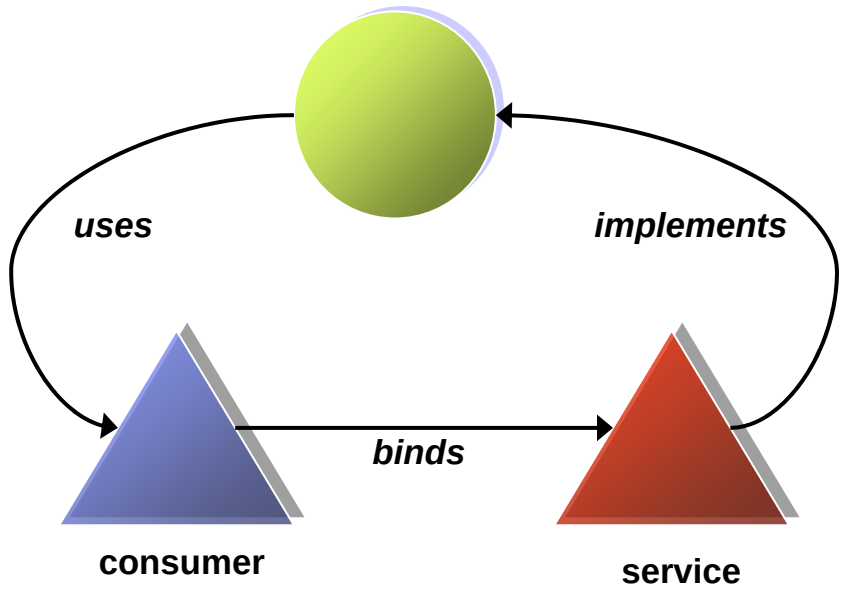
Declarative Services

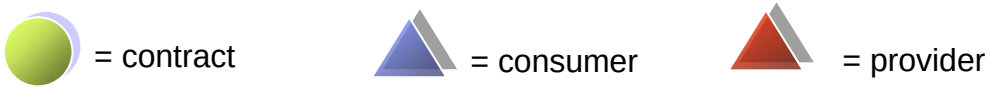
- Declarative service model build upon service registry
  - Adds a declarative mechanism specifying
    - Provided service
    - References services
  - Simplified programming model
    - POJO with dependency injection and contextualized lookup
  - Can conceal dynamism of services from programmer
  - Lazy loading of service class
  - Lifecycle managed by central runtime
  - Interoperates with service registry
- Vaguely similar to Spring but supports the dynamic component model of OSGi and Eclipse

Extensions



Services





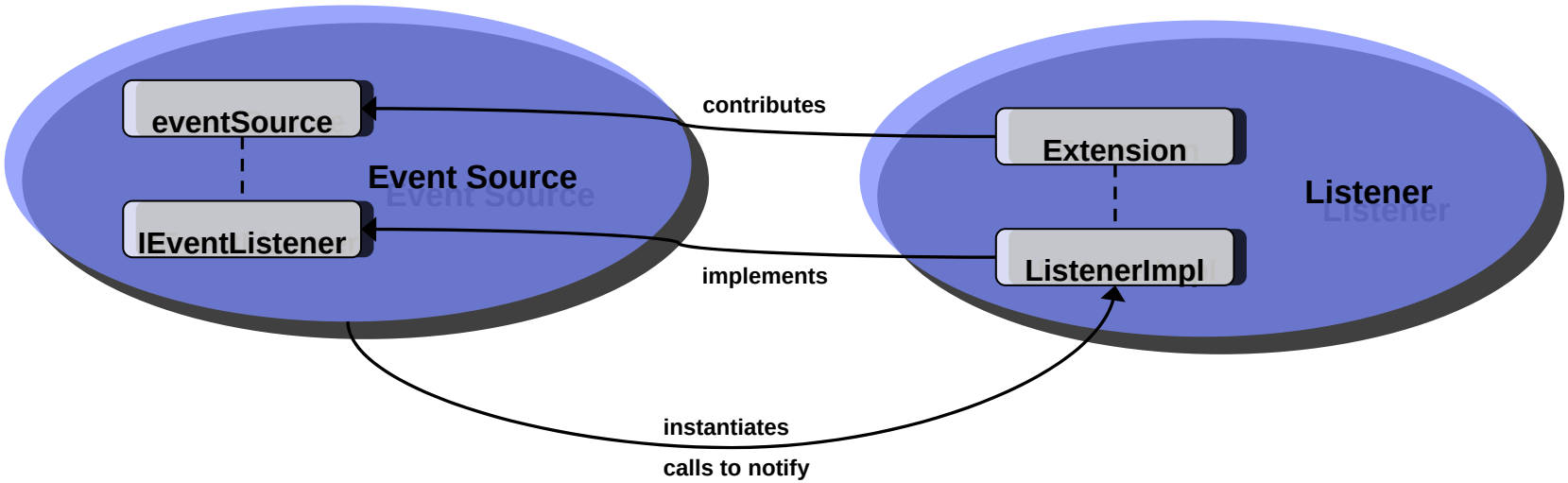
Example: Event Listeners

- Event listeners are connected to the event source
- An event is fired and the event source must notify each event listener
- Event listeners can supply metadata describing interest in event, for example:
  - Event subtypes of interest
  - Frequency of notification
  - etc.

Extension Approach

- Event source
  - Declaratively defines and exposes extension point (e.g. **`eventSource`**)
  - Defines the listener interface (e.g. **`IEventListener`**)
- Listener
  - Implements **`IEventListener`**
  - Declaratively contributes extension for the **`eventSource`** extension point that defines
    - **`IEventListener`** class to run
    - Listener metadata
- Event source extension point discovers each registered **`IEventListener`** extension
- When an event is fired, the event source
  - Evaluates the event against each listener extension's metadata
  - Can then load and run the listener's code to deliver the event

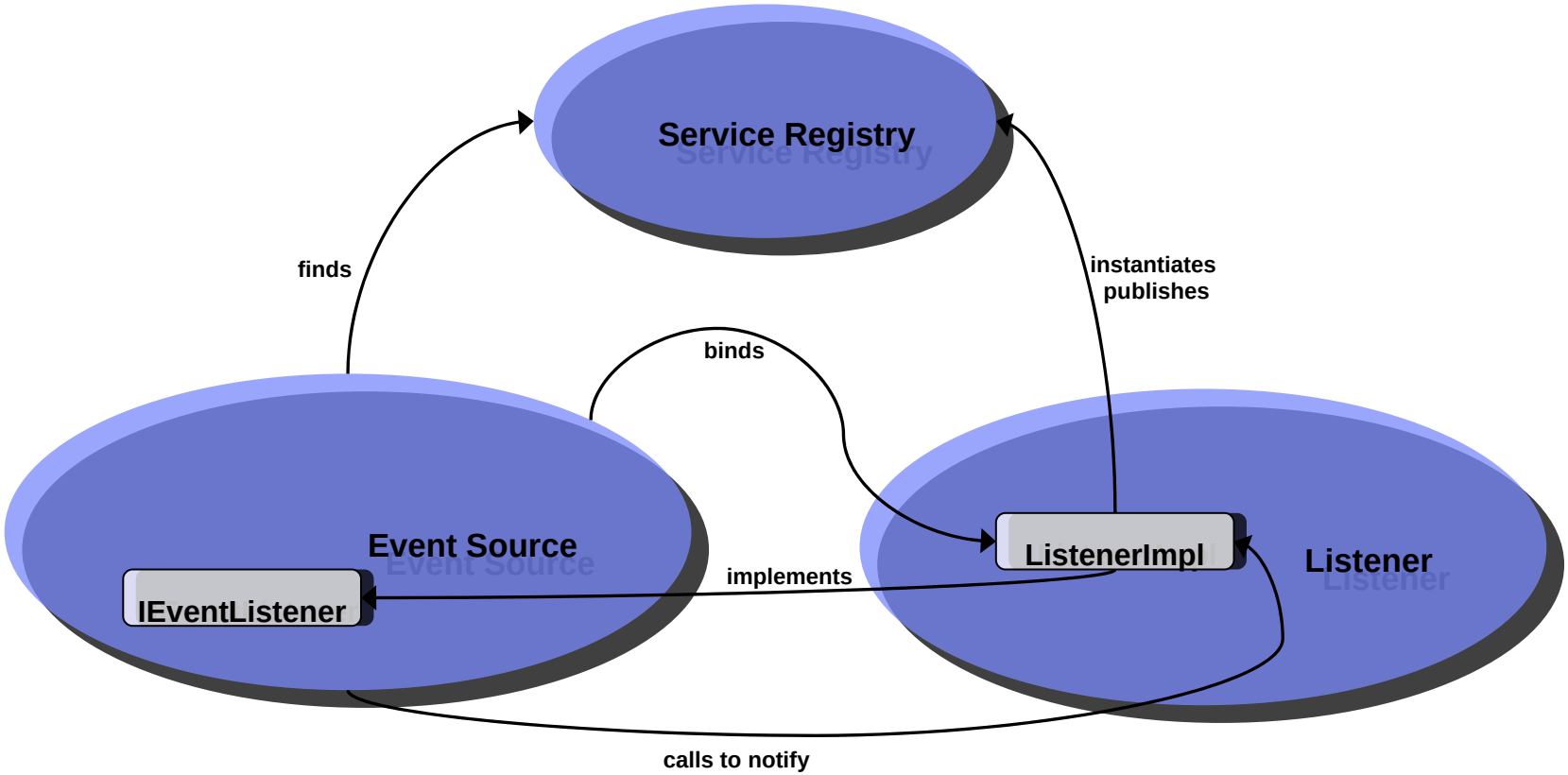
Extension Approach



Services Approach: Whiteboard

- Event source
  - Defines the listener interface (e.g. **`IEventListener`**)
- Listeners
  - Implements **`IEventListener`**
  - Registers an **`IEventListener`** instance as a service with properties containing listener metadata
- When an event is fired, event source
  - Finds all registered **`IEventListener`** services
  - Evaluates the event against each listener service's metadata
  - Can then bind to and run the listener's code to deliver the event

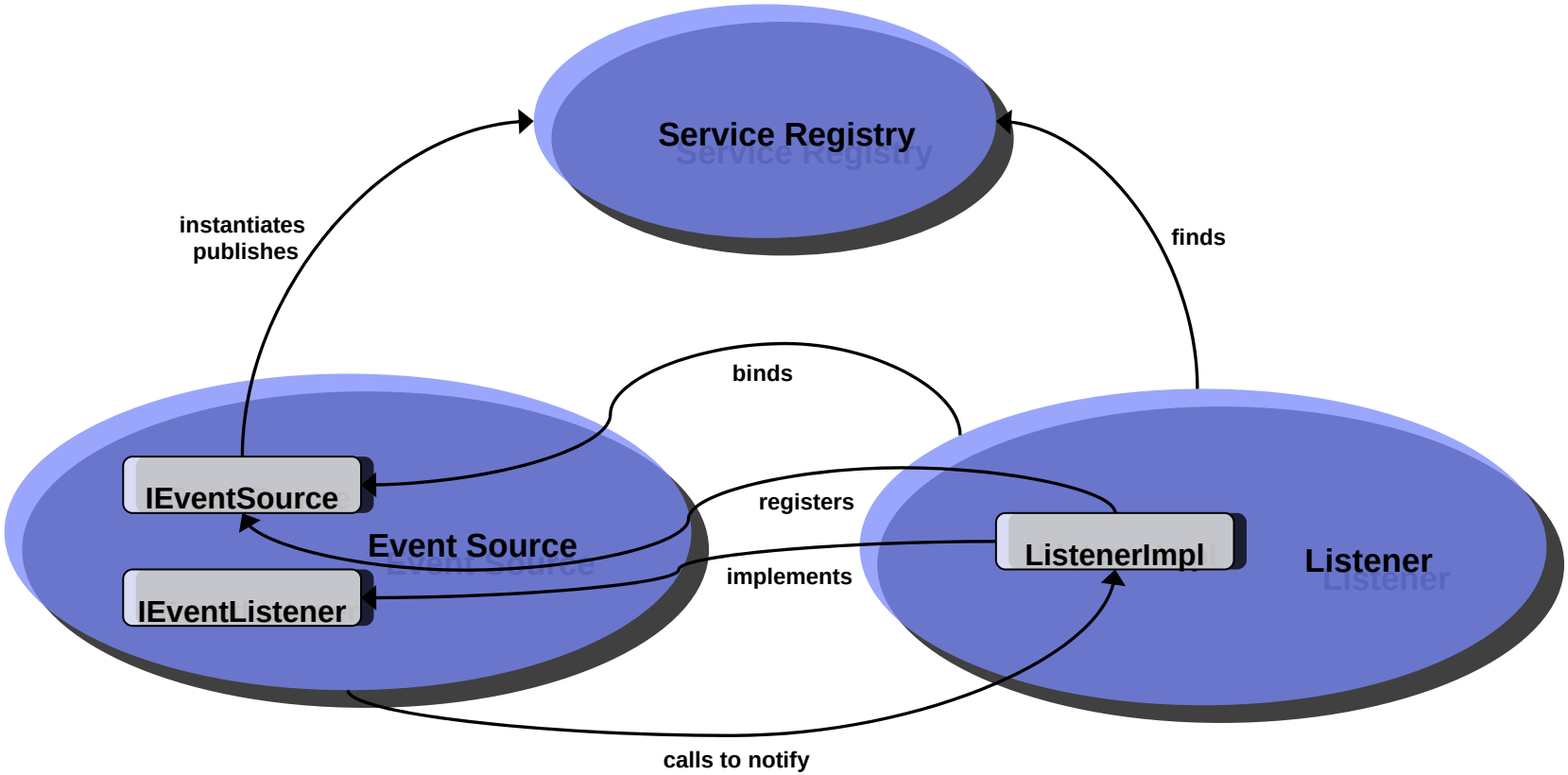
Services Approach: Whiteboard



Services Approach: Registration

- Event source
  - Defines the event source interface (e.g. **`IEventSource`**)
  - Defines the listener interface (e.g. **`IEventListener`**)
  - Implements **`IEventSource`**
  - Registers an **`IEventSource`** instance as a service
- Listeners
  - Implements **`IEventListener`**
  - Finds and binds to the **`IEventSource`** service
  - Registers an **`IEventListener`** instance with the **`IEventSource`** service along with listener metadata
- When an event is fired, event source
  - Evaluates the event against each listener's metadata
  - Can then run the listener's code to deliver the event

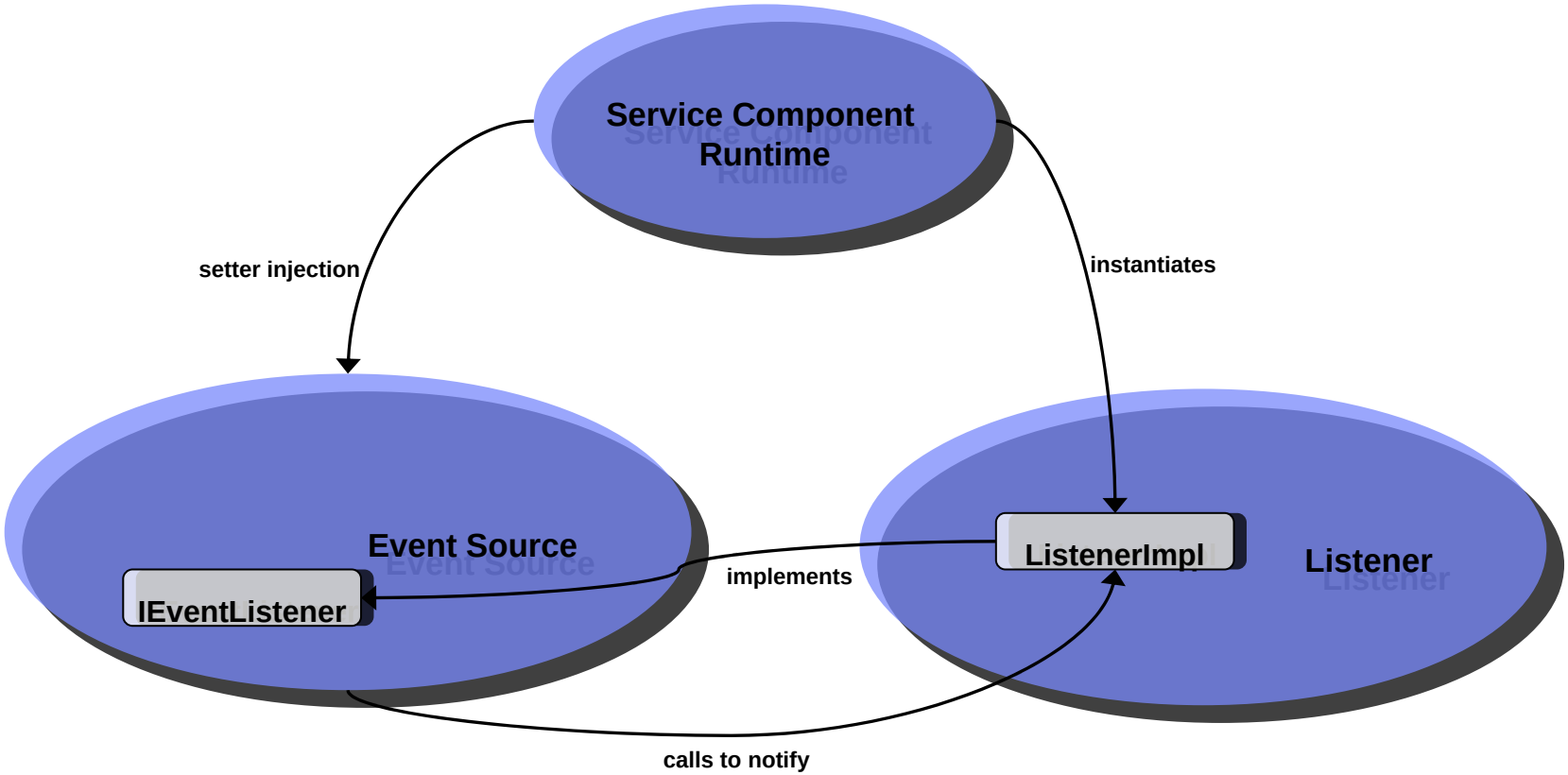
Services Approach: Registration



Declarative Services Approach: IoC Whiteboard

- Event source
  - Defines the listener interface (e.g. **`IEventListener`**)
  - Declaratively defines component with a dynamic, 0..n cardinality, dependency injection reference to **`IEventListener`** services
- Listeners
  - Implements **`IEventListener`**
  - Declaratively defines component providing **`IEventListener`** service with listener metadata
- SCR will create and inject instance of **`IEventListener`** service into event source component
- When an event is fired, event source
  - Queries listener for metadata and evaluates the event against metadata
  - Can then run the listener's code to deliver the event

Declarative Services Approach: IoC Whiteboard



Discussion

- In Extension and Service Registration approaches, the listener is able to select the specific event source with which it's listener will be registered
  - Names extension point of extension/binds to event source service
- In the Service Whiteboard and Declarative Services, control is inverted and the event source select the listener

- Extension approach allows lazy loading of listener class
- The Services approaches require eager loading of listener class
- The Declarative Service with DI also requires eager loading but a variation can be made which allows lazy loading at the "expense" of using container API
  - Contextualized lookup
  - Injection of ServiceReference

Compare and Contrast

- Extensions
  - Private contract with specific consumer (extension point)
  - Can deliver data-only payload
  - Lazily loaded and run
  - Lifecycle scoped to resolved state of bundles
- Services
  - Public contract
  - No data-only payload
  - Eager loading
  - Lifecycle scoped to started state of bundles
- Declarative Services
  - Public contract
  - No data-only payload
  - Lazily loaded and run
  - Lifecycle scoped to started state of bundles

Best Practices: Collaboration

- Extension Registry
  - Use when a tightly coupled relationship exists such as contributing UI elements
- Declarative Services
  - Use when providing a service usable by any consumer (loosely coupled relationship) such as a data validation service
  - Use when substitutability of service providers and consumers is desired
- Service Registry
  - Same as Declarative Services
  - But Declarative Services is preferred unless you have a complex need outside scope of Declarative Service's capabilities
  - Useful for highly dynamic service such as publication upon external event

