adaptTo()

APACHE SLING & FRIENDS TECH MEETUP

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OSGi µServices

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Co-author of „OSGi in Action“

Outline

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- Motivating µServices
  - Procedures
  - Objects
  - Interfaces
  - Factories
  - Dependency injection
- Service orientation
  - µServices and OSGi Services
  - Dynamism
  - Service Dependency Injection
- Example
  - Declarative Services with Configuration Admin Service

Motivating µServices

Motivating µServices

	Data encapsulation/abstraction
	Provider/Consumer coupling
	Provider/Consumer control
	Provider/Consumer dynamism

Procedures

```
byte[4096] canvas;

void mouseClickCallback(int x, int y) {
  drawCircle(x, y, 100);
}

void drawCircle(int x, int y, int r) {
  ...
  // draws into canvas
  ...
}
```

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Objects

```
public abstract class Shape {
  public void draw(Canvas c);
}
public class Paint {
  private Canvas;
  private Shape;
  public Paint(Canvas canvas, Shape shape) { … }

  public void mouseClick(int x, int y) {
    shape.draw(canvas, x, y);
  }
  public static void main() {
    new Paint(
      new Canvas(),
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Factories

```
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public class ShapeFactory {
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Dependency injection

```
public class Paint implements ShapeConsumer {
  @Inject
  public Paint(Shape shape) { … }
}
public class ShapeModule extends AbstractModule {
  @Override
  protected void configure() {
    bind(Shape.class).to(Circle.class);
    bind(ShapeConsumer.class).to(Paint.class);
  }
}

Injector injector =
     Guice.createInjector(
          new ShapeModule());
ShapeConsumer consumer =
     injector.getInstance(
          ShapeConsumer.class);
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Context and Dependency Injection (CDI)

```
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  @Inject
  public Shape shape;
}
@Default
public class CircleProducer {
  @Produces
  protected Shape createShape() {
    return new CircleImpl();
  }
}

Paint paint =
     beanContainer.getBeanByType(
          Paint.class);
```

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Service Orientation

Service orientation

- Promoting a service-oriented interaction pattern

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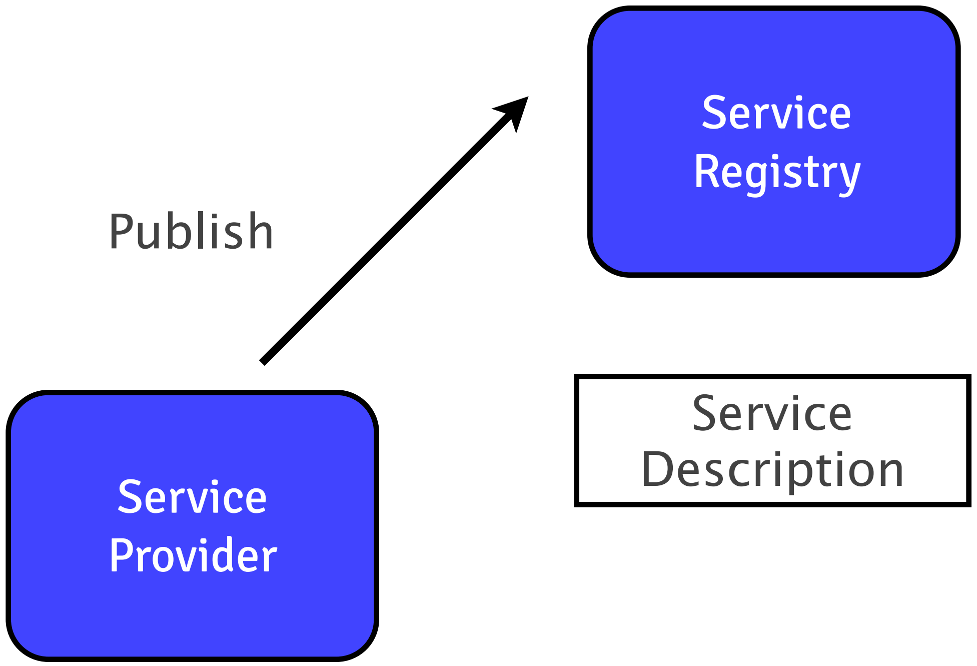
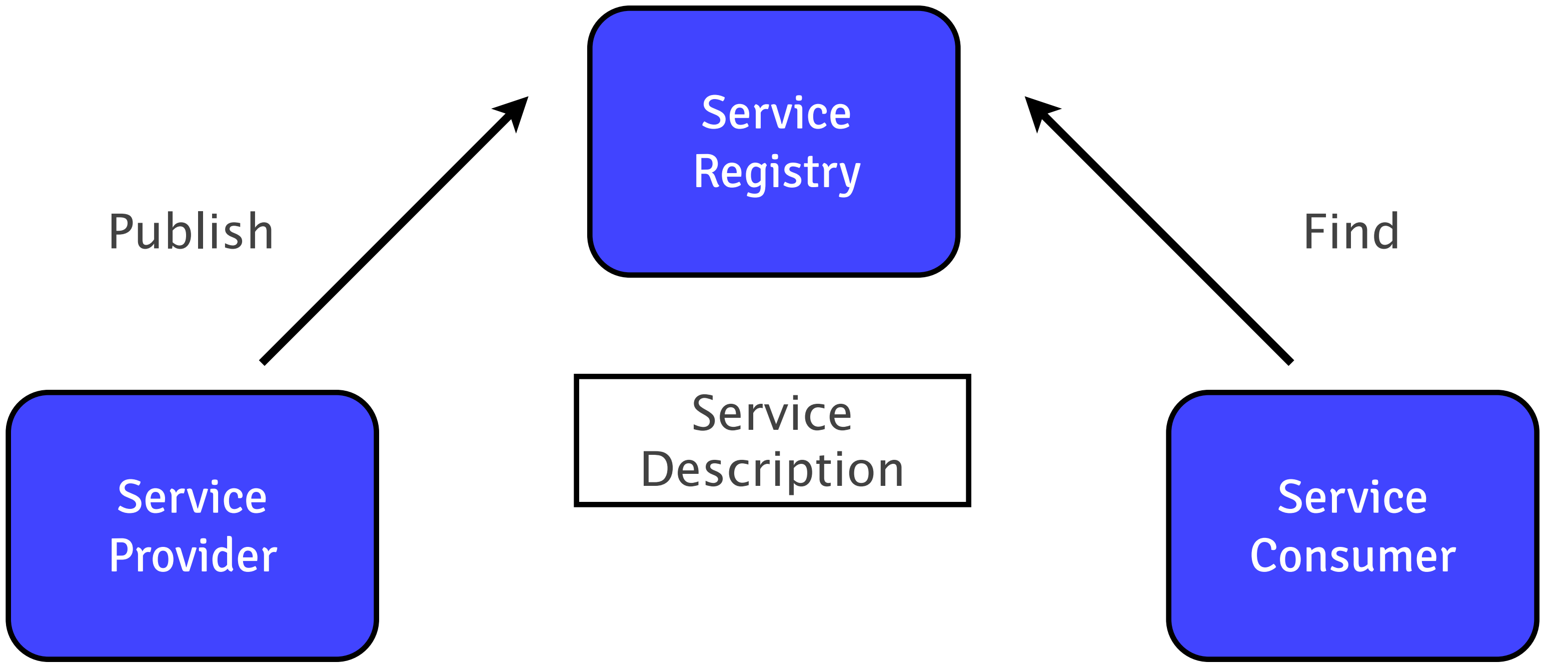
Service orientation

- Promoting a service-oriented interaction pattern



Service orientation

- Promoting a service-oriented interaction pattern



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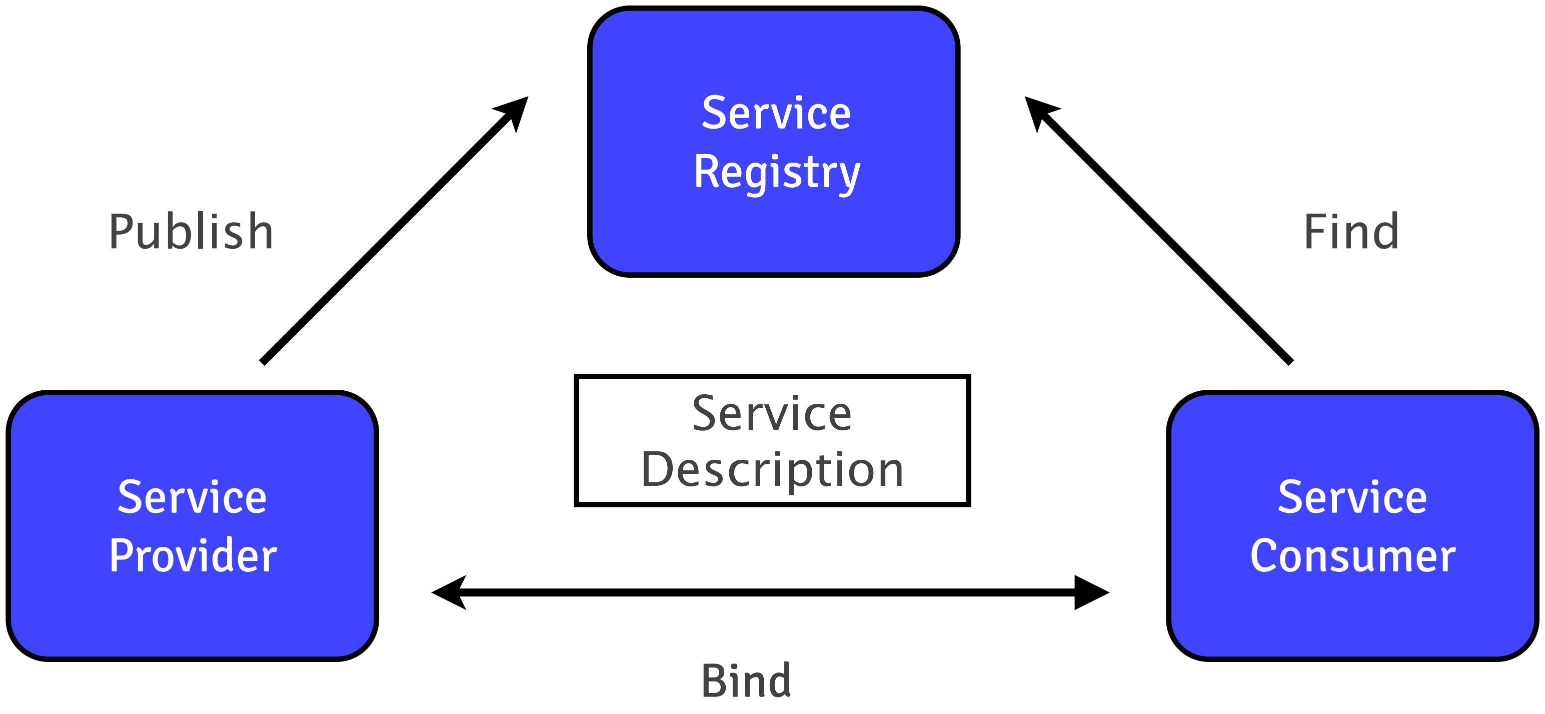

µServices

- Interface-based programming, but more
- Service Registry
  - Centrally accessible
  - Browsable
  - Notifications

- Service Registry Benefits
  - Consuming code is in control of provider selection
    - But not provider instantiation and configuration
  - Provider code is in control of when to provide
  - Promotes very loose coupling and late binding

META-INF/services

```
ServiceLoader<ShapeFactory> factories =
  ServiceLoader.load(ShapeFactory.class);

List<Shape> shapes = …

for (ShapeFactory factory : factories) {

    shapes.add(factory.next().createShape());

}
```

🙂	Data encapsulation/abstraction
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OSGi services

- OSGi framework provides the concepts we need
  - Centralized service registry
  - Consumer has control over selection
  - Provider has control over when to provide
  - Plus full-blown deployment and packaging modularity with run-time dynamism

OSGi service advantages

- Lightweight services
  - Direct method invocation
- Structured code
  - Promotes separation of interface from implementation
  - Enables reuse, substitutability, loose coupling, and late binding
- Dynamics
  - Loose coupling and late binding make it possible to support run-time management of module

Using a service (1/2)

- `BundleContext` allows bundles to find services

```
public interface BundleContext {
  …
  ServiceReference[] getServiceReferences(...);
  ServiceReference getServiceReference(...);
  Object getService(...);
  boolean ungetService(...);
}
```

Using a service (2/2)

```
public class Paint implements BundleActivator {
  public void start(BundleContext context) {
    ServiceReference ref =
context.getServiceReference(
      com.foo.Shape.class.getName());
    if (ref != null) {
      Shape s = (Shape) context.getService(ref);
      if (s != null) {
        ...
        context.ungetService(
           ref);
      }
    }
  }
}
```

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Publishing a service (1/2)

- BundleContext allows bundles to publish services

```
public interface BundleContext {
  ...
  ServiceRegistration registerService(...);
  ...
}
```

Publishing a service (1/2)

```
public class Activator implements BundleActivator {
  private ServiceRegistration reg = null;

  public void start(BundleContext context) {
    reg = context.registerService(
      com.foo.Shape.class.getName(),
      new Circle(100), null);
  }
  public void stop(
       BundleContext
           context) {
    reg.unregister();
  }
}
```

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Service dynamism

- Services can be monitored

BundleContext.**addServiceListener**()

```
public interface ServiceListener extends
EventListener {
  public void serviceChanged(ServiceEvent event);
}

public class ServiceEvent extends EventObject {
  public final static int REGISTERED;
  public final static int MODIFIED;
  public final static int UNREGISTERING;
    ...
}
```

Bundle-based dynamism

- Bundle lifecycle state provides a hook for bundle-based dynamic extensibility
- The extender pattern
  - An application component, called the extender, listens for bundles to be started, and stopped
  - On startup, the extender probes bundles to see if they are extensions
    - Typically, extension contain special metadata or resources to indicate they provide an extension
  - When an extension is started, the extender integrates the extension into the application
  - When an extension is stopped, the extender removes the extension from the application

Service-based dynamism

- Service lifecycle state provides a hook for service-based dynamic extensibility
  - Still overall controlled by bundle state, but more fine grained
- Treats the service registry as a whiteboard
  - A reverse way to create a service
- An application component listens for services of a particular type to be added and removed
- On addition, the service is integrated into the application
- On removal, the service is removed from the application

Service dynamism

- Services can be monitored

```
BundleContext.addServiceListener()

public interface ServiceListener extends EventListener {
  public void serviceChanged(ServiceEvent event);
}
public class ServiceEvent extends EventObject {
  public final static int REGISTERED;
  public final static int MODIFIED;
  public final static int UNREGISTERING;
  public ServiceReference
        getServiceReference() { … }
  public int getType() { … }
  ...
}
```

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Services and dependency injection

- Services and dependency injection
  - Complementary
- Use POJOs
  - Avoid dependencies on OSGi API

Services and dependency injection

- Here is a component providing the service

```
@Component
public class Circle implements Shape {
...
}
```

Services and dependency injection

- Here is a component providing the service

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@Component
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- Implementation with service dependency

```
@Component
public class Paint {
  @Reference
  public void setShape(Shape shape)
{...}
  public void useShape() {... }
}
```

Services and dependency injection

- Here is a component providing the service

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@Component
public class Circle implements Shape {
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- Implementation with service dependency

```
@Component
public class Paint {
  @Reference
  public void setShape(Sh
{...}
  @Activate
  public void useShape() {... }}
```

Bundle activator no longer necessary, but lifecycle control still possible

Services and dependency Injection

- Advantages when combined with service orientation
  - Dependency injection no longer needs global view
    - Information localized to just the provider/ consumer
  - No longer restricted to a single DI framework
    - Different DI frameworks can play together via the service registry

Example

Declarative Services with Configuration Admin Service

```
@Component(
   configurationPolicy=ConfigurationPolicy.REQUIRE)
public class Circle implements Shape {
...
   private volatile String color;

   @Activate
   public void init(Map config){
      this.color = config.get(COLOR_KEY); }
}
```

Declarative Services with Configuration Admin Service

```
@Component(immediate=true)
public class Paint {

@Reference(
   cardinality=ReferenceCardinality.MULTIPLE,
   policyOption=ReferencePolicyOption.DYNAMIC
   )
  public void setShape(Shape shape) {...}
  public void unsetShape(Shape shape){...}

@Activate
  public void drawFrame() { ...}
@Deactivate
  public void dispose(){...}
}
```

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```

Conclusion

- OSGi µServices
  - Promote separation of interface from implementation
  - Enable reuse, substitutability, loose coupling, and late binding
  - Provide (dynamic) services via a service registry
    - Loose coupling and late binding make it possible to support run-time management of module

Questions?