IOC 过程

1）定位

2）加载

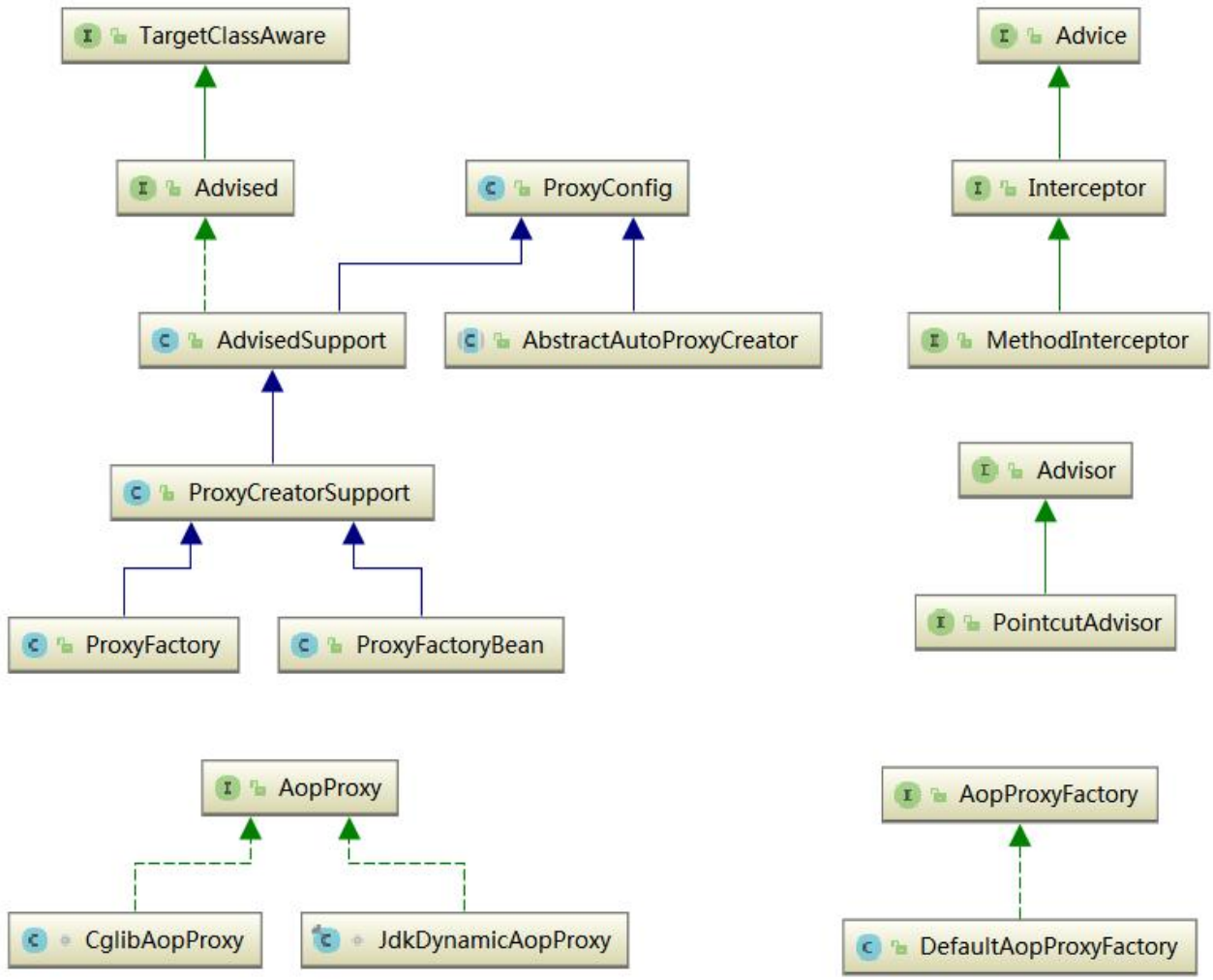
3）注册

4）初始化

5）注入

IOC容器 ------》ConcurrentHashMap

AOP 依赖IOC容器



`org.springframework.aop.framework.DefaultAopProxyFactory`

```
@Override
public AopProxy createAopProxy(AdvisedSupport config) throws AopConfigException {
   if (config.isOptimize() || config.isProxyTargetClass() ||
hasNoUserSuppliedProxyInterfaces(config)) {
      Class<?> targetClass = config.getTargetClass();
      if (targetClass == null) {
         throw new AopConfigException("TargetSource cannot determine target class: " +
               "Either an interface or a target is required for proxy creation.");
      }
      if (targetClass.isInterface() || Proxy.isProxyClass(targetClass)) {
         return new JdkDynamicAopProxy(config);
      }
      return new ObjenesisCglibAopProxy(config);
   }
   else {
      return new JdkDynamicAopProxy(config);
   }
}
```

以JDK动态代理为例

```
final class JdkDynamicAopProxy implements AopProxy, InvocationHandler, Serializable {}
```

AOP过程

1）加载配置信息，解析成`AopConfig`

2）交给`AopProxyFactory`，调用`createAopProxy`方法

3）`JdkDynamicAopProxy`调用`AdvisedSupport`的`getInterceptorsAndDynamicInterceptionAdvice`方法得到方法拦截器并保存到一个容器 ------》List

```
@Override
@Nullable
public Object invoke(Object proxy, Method method, Object[] args) throws Throwable {
   MethodInvocation invocation;
   Object oldProxy = null;
   boolean setProxyContext = false;
```

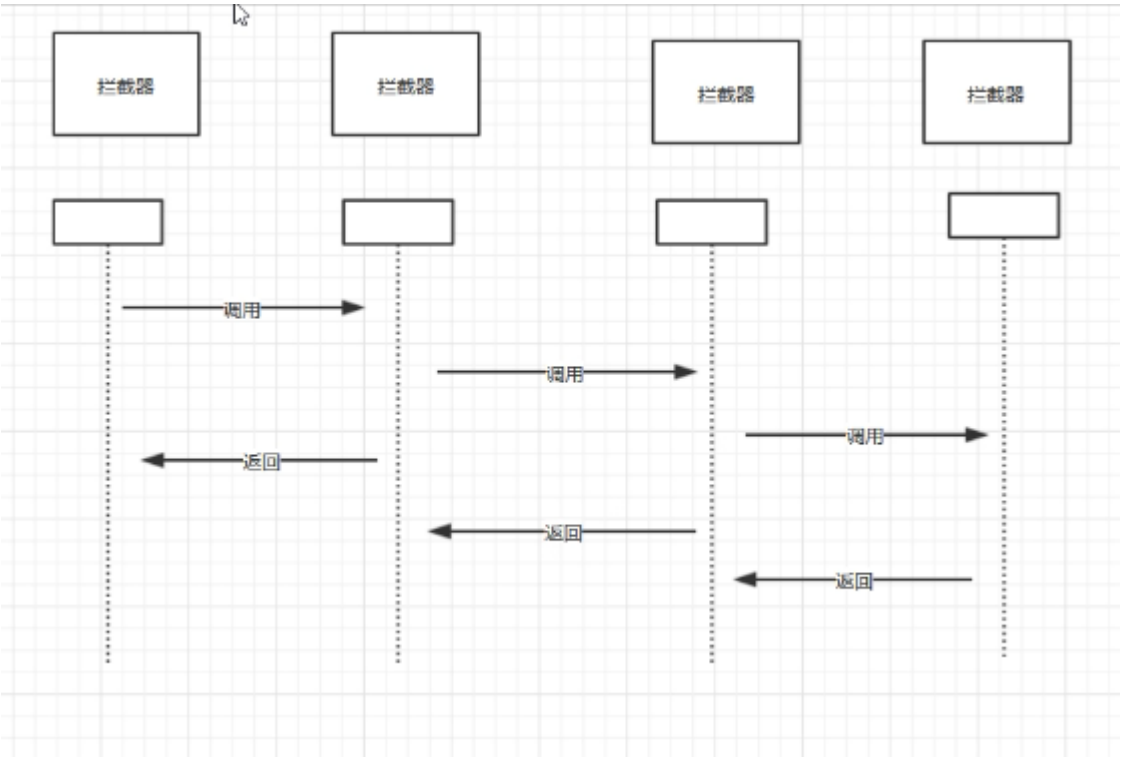
```
   TargetSource targetSource = this.advised.targetSource;
   Object target = null;

   try {
      if (!this.equalsDefined && AopUtils.isEqualsMethod(method)) {
         // The target does not implement the equals(Object) method itself.
         return equals(args[0]);
      }
      else if (!this.hashCodeDefined && AopUtils.isHashCodeMethod(method)) {
         // The target does not implement the hashCode() method itself.
         return hashCode();
      }
      else if (method.getDeclaringClass() == DecoratingProxy.class) {
         // There is only getDecoratedClass() declared -> dispatch to proxy config.
         return AopProxyUtils.ultimateTargetClass(this.advised);
      }
      else if (!this.advised.opaque && method.getDeclaringClass().isInterface() &&
            method.getDeclaringClass().isAssignableFrom(Advised.class)) {
         // Service invocations on ProxyConfig with the proxy config...
         return AopUtils.invokeJoinpointUsingReflection(this.advised, method, args);
      }

      Object retVal;

      if (this.advised.exposeProxy) {
         // Make invocation available if necessary.
         oldProxy = AopContext.setCurrentProxy(proxy);
         setProxyContext = true;
      }

      // Get as late as possible to minimize the time we "own" the target,
      // in case it comes from a pool.
      target = targetSource.getTarget();
      Class<?> targetClass = (target != null ? target.getClass() : null);

      // Get the interception chain for this method.
      List<Object> chain = this.advised.getInterceptorsAndDynamicInterceptionAdvice(method,
targetClass);

      // Check whether we have any advice. If we don't, we can fallback on direct
      // reflective invocation of the target, and avoid creating a MethodInvocation.
      if (chain.isEmpty()) {
         // We can skip creating a MethodInvocation: just invoke the target directly
         // Note that the final invoker must be an InvokerInterceptor so we know it does
         // nothing but a reflective operation on the target, and no hot swapping or fancy
proxying.
         Object[] argsToUse = AopProxyUtils.adaptArgumentsIfNecessary(method, args);
         retVal = AopUtils.invokeJoinpointUsingReflection(target, method, argsToUse);
      }
      else {
         // We need to create a method invocation...
```

```
            invocation = new ReflectiveMethodInvocation(proxy, target, method, args,
targetClass, chain);
            // Proceed to the joinpoint through the interceptor chain.
            retVal = invocation.proceed();
         }

         // Massage return value if necessary.
         Class<?> returnType = method.getReturnType();
         if (retVal != null && retVal == target &&
               returnType != Object.class && returnType.isInstance(proxy) &&
               !RawTargetAccess.class.isAssignableFrom(method.getDeclaringClass())) {
            // Special case: it returned "this" and the return type of the method
            // is type-compatible. Note that we can't help if the target sets
            // a reference to itself in another returned object.
            retVal = proxy;
         }
         else if (retVal == null && returnType != Void.TYPE && returnType.isPrimitive()) {
            throw new AopInvocationException(
                  "Null return value from advice does not match primitive return type for: " +
method);
         }
         return retVal;
      }
      finally {
         if (target != null && !targetSource.isStatic()) {
            // Must have come from TargetSource.
            targetSource.releaseTarget(target);
         }
         if (setProxyContext) {
            // Restore old proxy.
            AopContext.setCurrentProxy(oldProxy);
         }
      }
   }
```

```
public List<Object> getInterceptorsAndDynamicInterceptionAdvice(Method method, @Nullable
Class<?> targetClass) {
   MethodCacheKey cacheKey = new MethodCacheKey(method);
   List<Object> cached = this.methodCache.get(cacheKey);
   if (cached == null) {
      cached = this.advisorChainFactory.getInterceptorsAndDynamicInterceptionAdvice(
            this, method, targetClass);
      this.methodCache.put(cacheKey, cached);
   }
   return cached;
}
```

4）递归执行拦截器方法 org.springframework.aop.framework.ReflectiveMethodInvocation#proceed 方法

```
@Override
@Nullable
public Object proceed() throws Throwable {
   // We start with an index of -1 and increment early.
   if (this.currentInterceptorIndex == this.interceptorsAndDynamicMethodMatchers.size() -
1) {
      return invokeJoinpoint();
   }

   Object interceptorOrInterceptionAdvice =
         this.interceptorsAndDynamicMethodMatchers.get(++this.currentInterceptorIndex);
   if (interceptorOrInterceptionAdvice instanceof InterceptorAndDynamicMethodMatcher) {
      // Evaluate dynamic method matcher here: static part will already have
      // been evaluated and found to match.
      InterceptorAndDynamicMethodMatcher dm =
            (InterceptorAndDynamicMethodMatcher) interceptorOrInterceptionAdvice;
      if (dm.methodMatcher.matches(this.method, this.targetClass, this.arguments)) {
         return dm.interceptor.invoke(this);
      }
      else {
         // Dynamic matching failed.
         // Skip this interceptor and invoke the next in the chain.
         return proceed();
      }
   }
   else {
      // It's an interceptor, so we just invoke it: The pointcut will have
      // been evaluated statically before this object was constructed.
      return ((MethodInterceptor) interceptorOrInterceptionAdvice).invoke(this);
   }
}
```



对应的拦截器链：

```
<aop:pointcut id="pointCut" expression="execution(* com.leh.aop.service..*(..))"/>

<aop:before method="before" pointcut-ref="pointCut"/>

<aop:after method="after" pointcut-ref="pointCut"/>


<!--AfterReturning 增强处理将在目标方法正常完成后被织入-->
<aop:after-returning method="afterReturn" pointcut-ref="pointCut" returning="result"/>

<aop:after-throwing method="afterThrow" pointcut-ref="pointCut" throwing="ex"/>
```

最终是由一个advisor来调用切面中方法。

org.springframework.aop.framework.CglibAopProxy 分析：

内部类：

org.springframework.aop.framework.CglibAopProxy.DynamicAdvisedInterceptor#intercept

```
public Object intercept(Object proxy, Method method, Object[] args, MethodProxy
methodProxy) throws Throwable {
   Object oldProxy = null;
   boolean setProxyContext = false;
   Object target = null;
   TargetSource targetSource = this.advised.getTargetSource();
   try {
      if (this.advised.exposeProxy) {
         // Make invocation available if necessary.
         oldProxy = AopContext.setCurrentProxy(proxy);
         setProxyContext = true;
      }
      // Get as late as possible to minimize the time we "own" the target, in case it comes
from a pool...
      target = targetSource.getTarget();
      Class<?> targetClass = (target != null ? target.getClass() : null);
      List<Object> chain = this.advised.getInterceptorsAndDynamicInterceptionAdvice(method,
targetClass);
      Object retVal;
      // Check whether we only have one InvokerInterceptor: that is,
      // no real advice, but just reflective invocation of the target.
      if (chain.isEmpty() && Modifier.isPublic(method.getModifiers())) {
         // We can skip creating a MethodInvocation: just invoke the target directly.
         // Note that the final invoker must be an InvokerInterceptor, so we know
         // it does nothing but a reflective operation on the target, and no hot
         // swapping or fancy proxying.
         Object[] argsToUse = AopProxyUtils.adaptArgumentsIfNecessary(method, args);
         retVal = methodProxy.invoke(target, argsToUse);
      }
      else {
         // We need to create a method invocation...
         retVal = new CglibMethodInvocation(proxy, target, method, args, targetClass,
chain, methodProxy).proceed();
      }
      retVal = processReturnType(proxy, target, method, retVal);
      return retVal;
   }
   finally {
      if (target != null && !targetSource.isStatic()) {
         targetSource.releaseTarget(target);
      }
      if (setProxyContext) {
         // Restore old proxy.
```

```
            AopContext.setCurrentProxy(oldProxy);
        }
    }
}
```