《31 讲带你搞懂 SkyWalking》

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— 拉勾教育出品 —

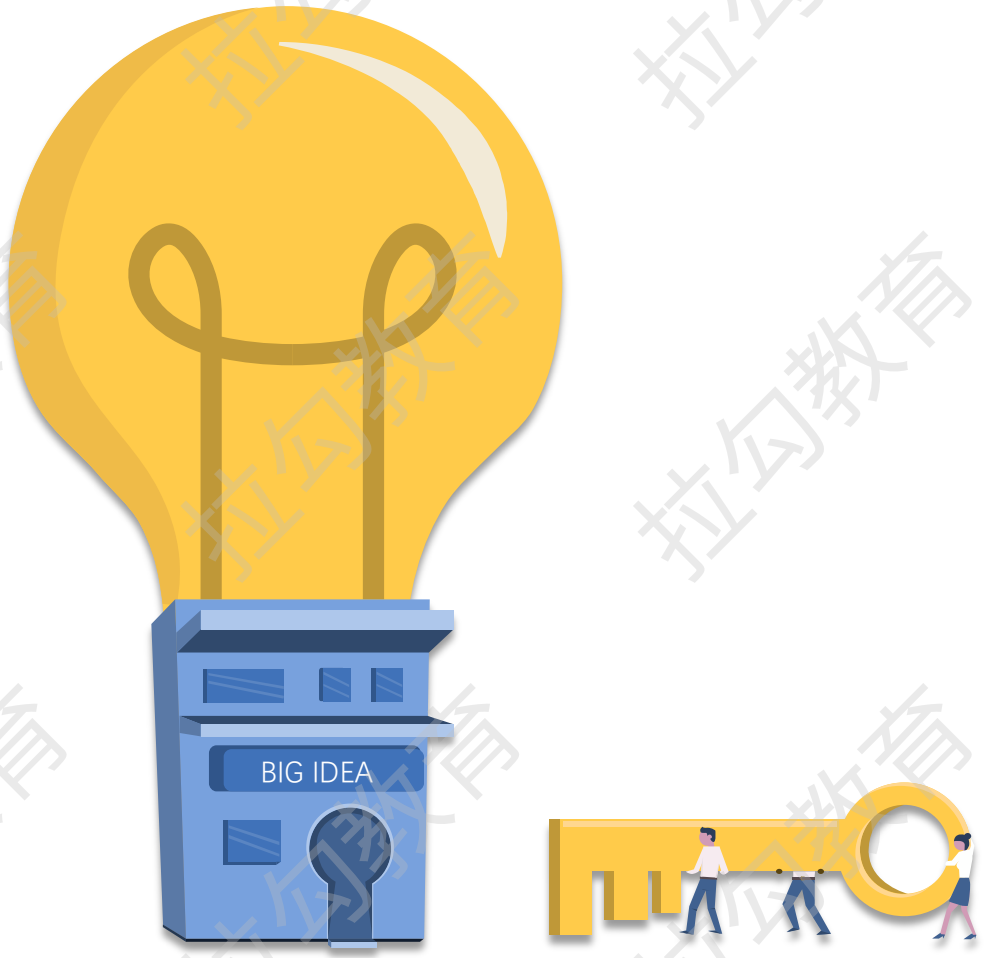
第16讲：Tomcat 插件原理精析
看 SkyWalking 如何增强这只 Cat（下）

TomcatInstrumentation

TomcatInstrumentation 插件类

重点关注四个问题：

1. 拦截哪个类
2. 拦截哪个方法
3. 由谁进行增强
4. 具体增强逻辑



TomcatInstrumentation

enhanceClass()方法返回的 ClassMatch 匹配了拦截的类名

```
protected ClassMatch enhanceClass() { // 拦截Tomcat的StandardHostValve类
    return byName("org.apache.catalina.core.StandardHostValve");
}
```

TomcatInstrumentation

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```
new InstanceMethodsInterceptPoint() {
    public ElementMatcher<MethodDescription> getMethodsMatcher() {
        return named(“invoke”); // 拦截名为 invoke 的方法
    }

    public String getMethodsInterceptor() {
        return "org.apache.skywalking.apm.plugin.tomcat78x
            .TomcatInvokeInterceptor “; // 拦截后的增强逻辑
    }

    public boolean isOverrideArgs() {
        return false; // 不修改 invoke()方法的参数
    }
}
```

TomcatInstrumentation

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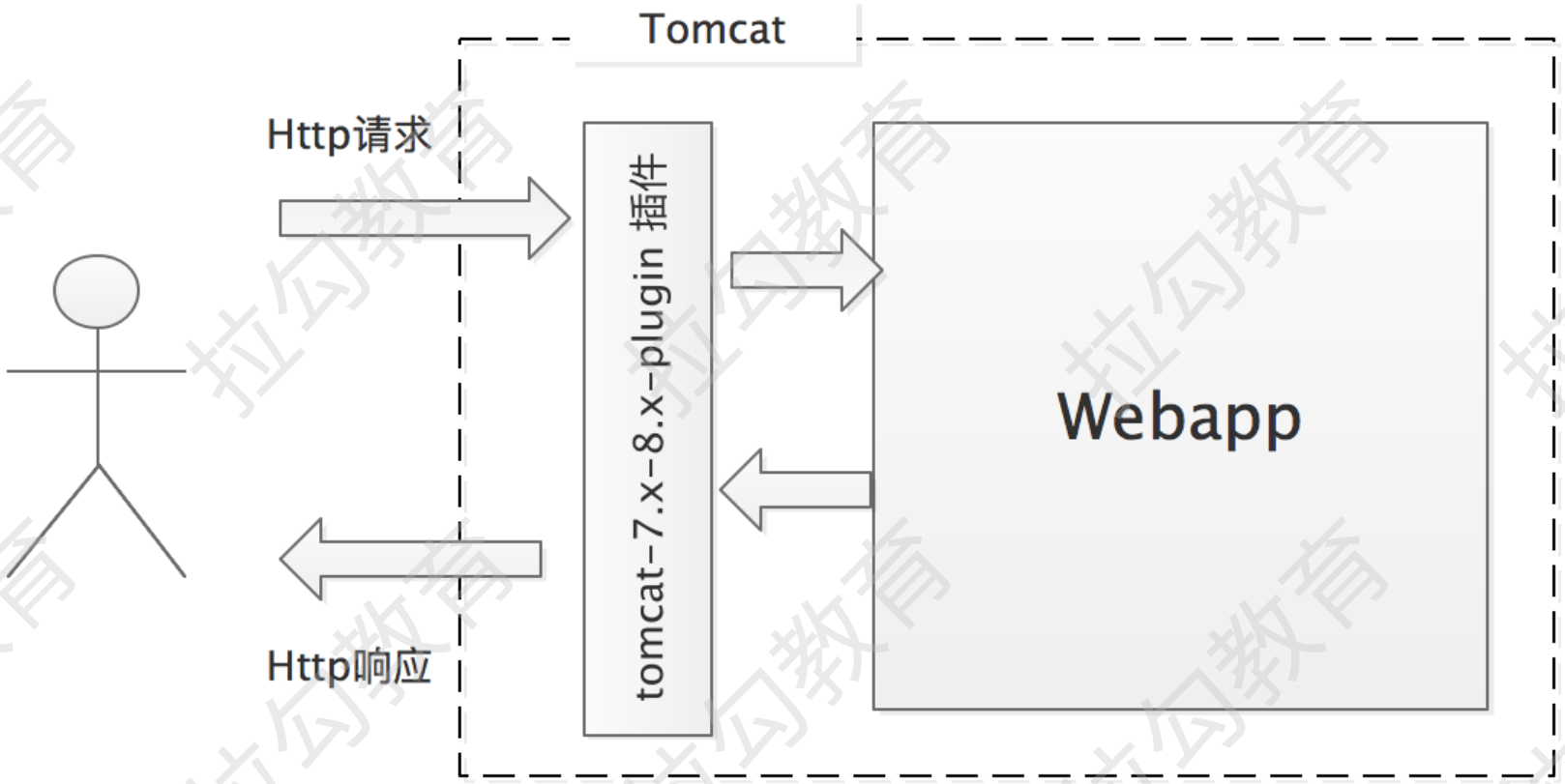
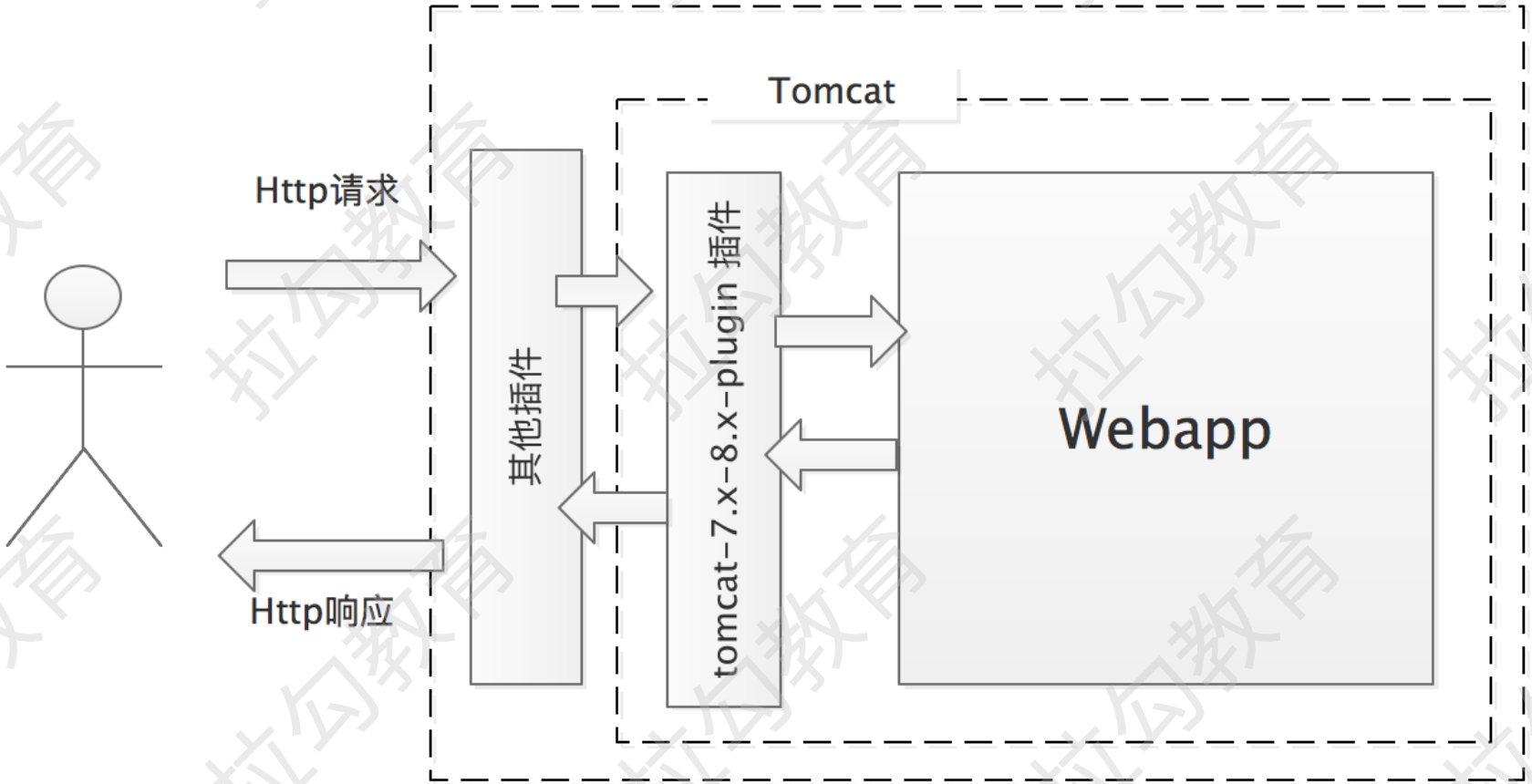
当 Tomcat 作为用户请求接入层的场景时



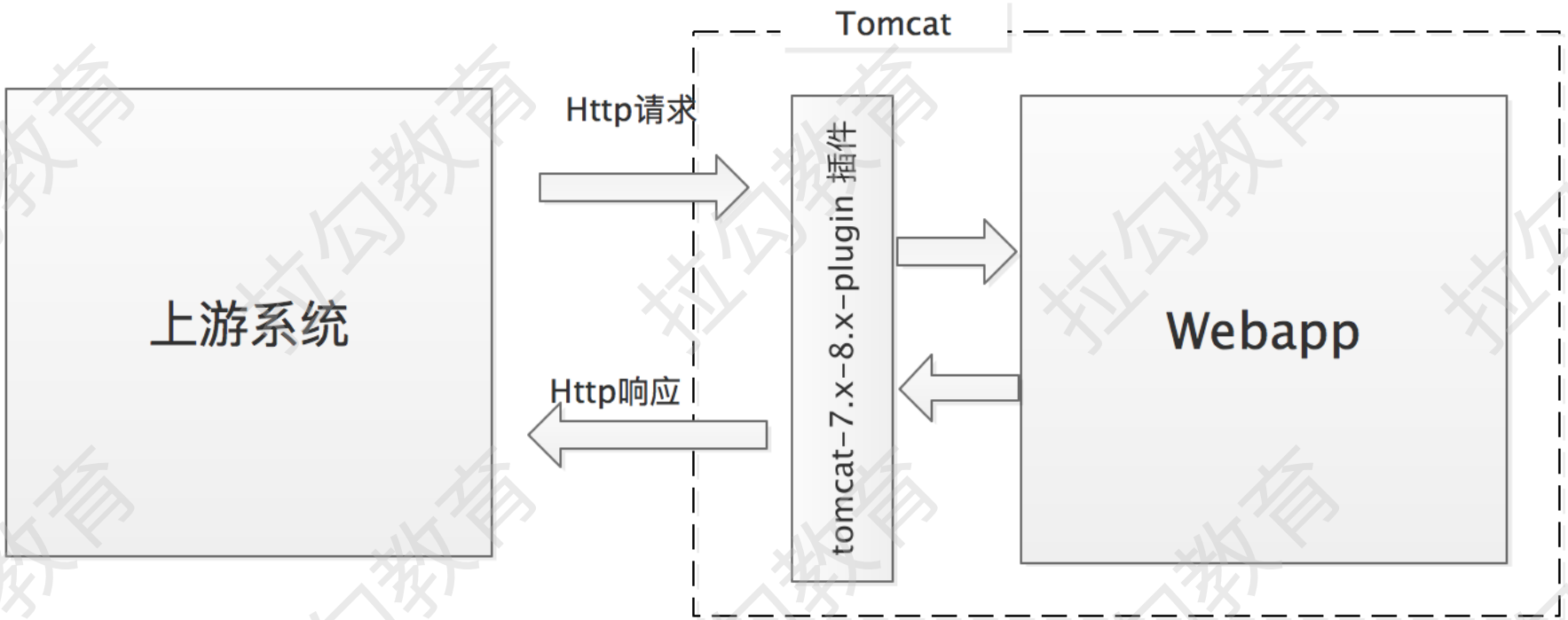
TomcatInstrumentation

tomcat-7.x-8.x-plugin 插件被嵌套在其他插件之后的场景



TomcatInstrumentation

Tomcat 作为下游系统被其他系统调用的场景



TomcatInstrumentation


```
public void beforeMethod(EnhancedInstance objInst, Method method,
    Object[] allArguments, Class<?>[] argumentsTypes,
      MethodInterceptResult result) throws Throwable {
  // invoke()方法的第一个参数就是HttpServletRequest对象
  HttpServletRequest request = (HttpServletRequest)allArguments[0];
  //创建一个空的ContextCarrier对象
  ContextCarrier contextCarrier = new ContextCarrier();
  //从Http请求头中反序列化ContextCarrier
  CarrierItem next = contextCarrier.items();
  while (next.hasNext()) {
    next = next.next();
    next.setHeadValue(request.getHeader(next.getHeadKey()));
  }
  //获取当前线程绑定的TracingContext，如果未绑定则会创建新TracingContext并
  //绑定，同时还会创建EntrySpan，如果已存在EntrySpan，则再次调用其start()方
  //法 。这里的第一个参数是operationName(即EndpointName)，Tomcat的场景下
  //就是请求的 URI
  AbstractSpan span = ContextManager.createEntrySpan(
    request.getRequestURI(), contextCarrier);
```

TomcatInstrumentation


```
ContextCarrier contextCarrier = new ContextCarrier();
//从Http请求头中反序列化ContextCarrier
CarrierItem next = contextCarrier.items();
while (next.hasNext()) {
  next = next.next();
  next.setHeadValue(request.getHeader(next.getHeadKey()));
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//获取当前线程绑定的TracingContext，如果未绑定则会创建新TracingContext并
//绑定，同时还会创建EntrySpan，如果已存在EntrySpan，则再次调用其start()方
//法。这里的第一个参数是operationName(即EndpointName)，Tomcat的场景下
//就是请求的URI
AbstractSpan span = ContextManager.createEntrySpan(
  request.getRequestURI(), contextCarrier);
//为EntrySpan添加Tags，记录请求的URL以及Method信息
Tags.URL.set(span, request.getRequestURL().toString());
Tags.HTTP.METHOD.set(span, request.getMethod());
span.setComponent(ComponentsDefine.TOMCAT); //设置component字段
SpanLayer.asHttp(span); // 匹配 layer 字段
}
```
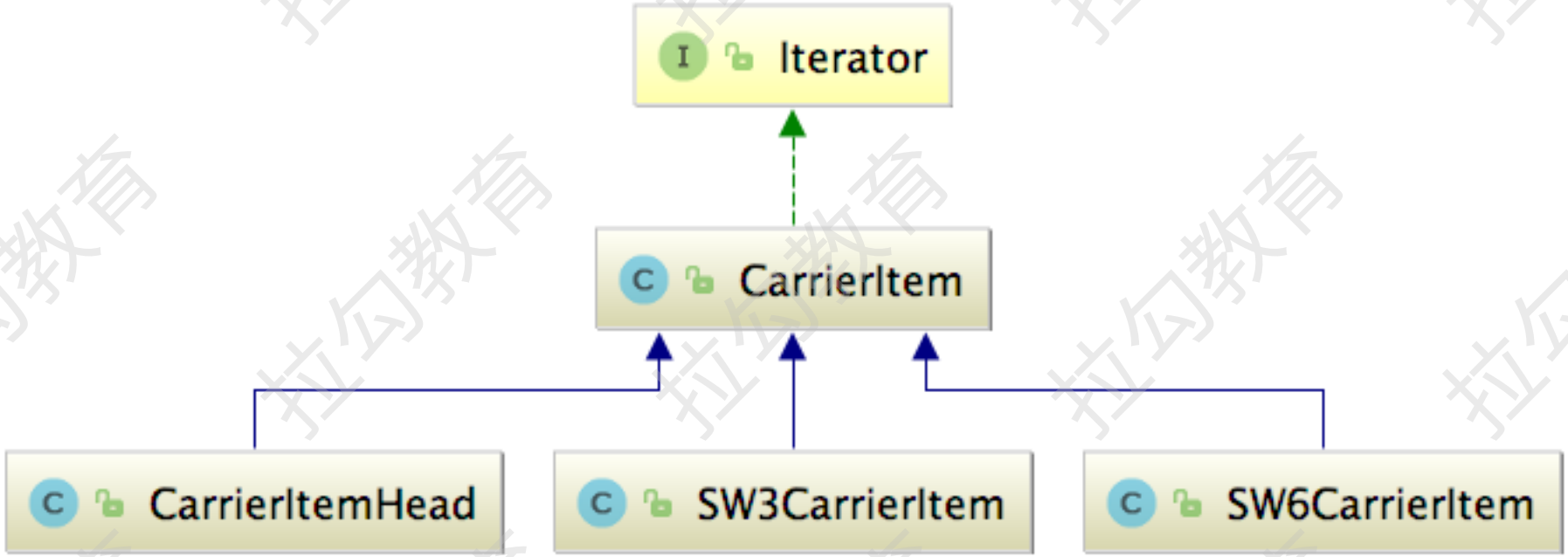
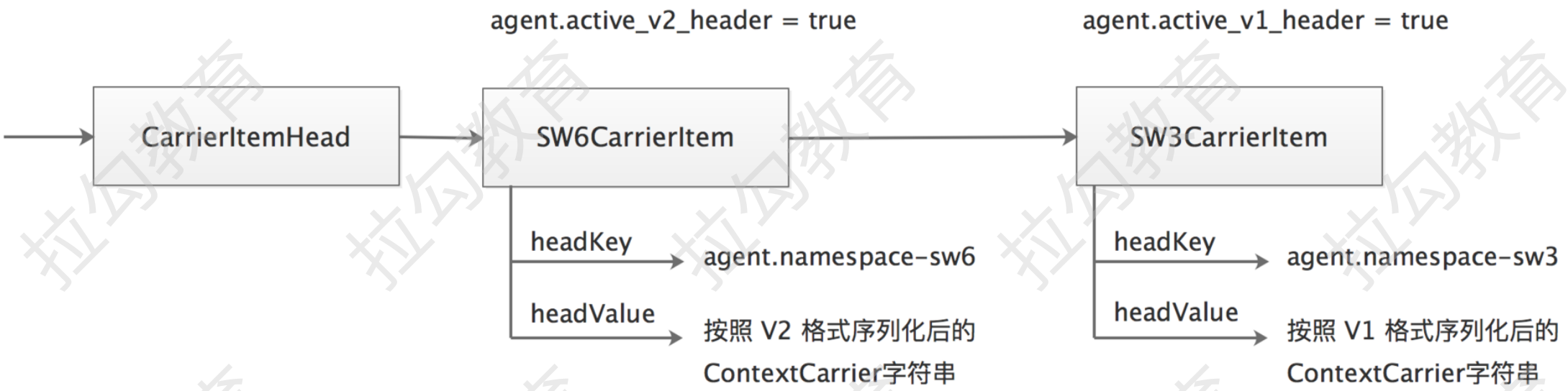

再探 ContextCarrier



再探 ContextCarrier



再探 ContextCarrier

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```
public SW6CarrierItem(ContextCarrier carrier, CarrierItem next) {
    super(HEADER_NAME,  // headKey
     // 按照V2版本序列化得到headValue
     carrier.serialize(ContextCarrier.HeaderVersion.v2),
     next); // 下一个CarrierItem节点
    this.carrier = carrier; // 记录关联的ContextCarrier对象
}
```

再探 ContextCarrier


```
//创建空的ContextCarrier对象
ContextCarrier contextCarrier = new ContextCarrier();
//创建CarrierItem链表，因为ContextCarrier对象是空的，所以链表也是空的
CarrierItem next = contextCarrier.items();
while (next.hasNext()) {
  next = next.next();
  //拿到HttpHeader的Value，即对应版本的ContextCarrier序列化字符串
  next.setHeadValue(request.getHeader(next.getHeadKey()));
}
```

再探 ContextCarrier

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```
public Object afterMethod(EnhancedInstance objInst, Method method,
    Object[] allArguments, Class<?>[] argumentsTypes,
        Object ret) throws Throwable {
    //invoke()方法的第二个参数是HttpServletResponse
    HttpServletResponse response =
        (HttpServletResponse)allArguments[1];
    // 获取当前Span，因为TracingContext是栈的形式管理Span，当前Span即为
    // beforeMethod()方法中创建的EntrySpan
    AbstractSpan span = ContextManager.activeSpan();
    if (response.getStatus() >= 400) {
        // 如果响应码是4xx或是5xx，则表示Http相应异常，标记当前Span的
        // errorOccurred字段，并记录一个Key为status_code的Tag
```

再探 ContextCarrier


```
        // errorOccurred字段，并记录一个Key为status_code的Tag
        span.errorOccurred();
        Tags.STATUS_CODE.set(span,
            Integer.toString(response.getStatus()));
    }
    //关闭当前EntrySpan，如果EntrySpan完全关闭，则整个Span栈为空
    //所在的TraceSegment也将随之关闭，这些逻辑在前面已经详细介绍过了
    ContextManager.stopSpan();
    //从RuntimeContext中清理FORWARD_REQUEST_FLAG信息，其含义后面再说
    ContextManager.getRuntimeContext().remove(
            Constants.FORWARD_REQUEST_FLAG);
    return ret;
}
```

ApplicationDispatcherInstrumentation

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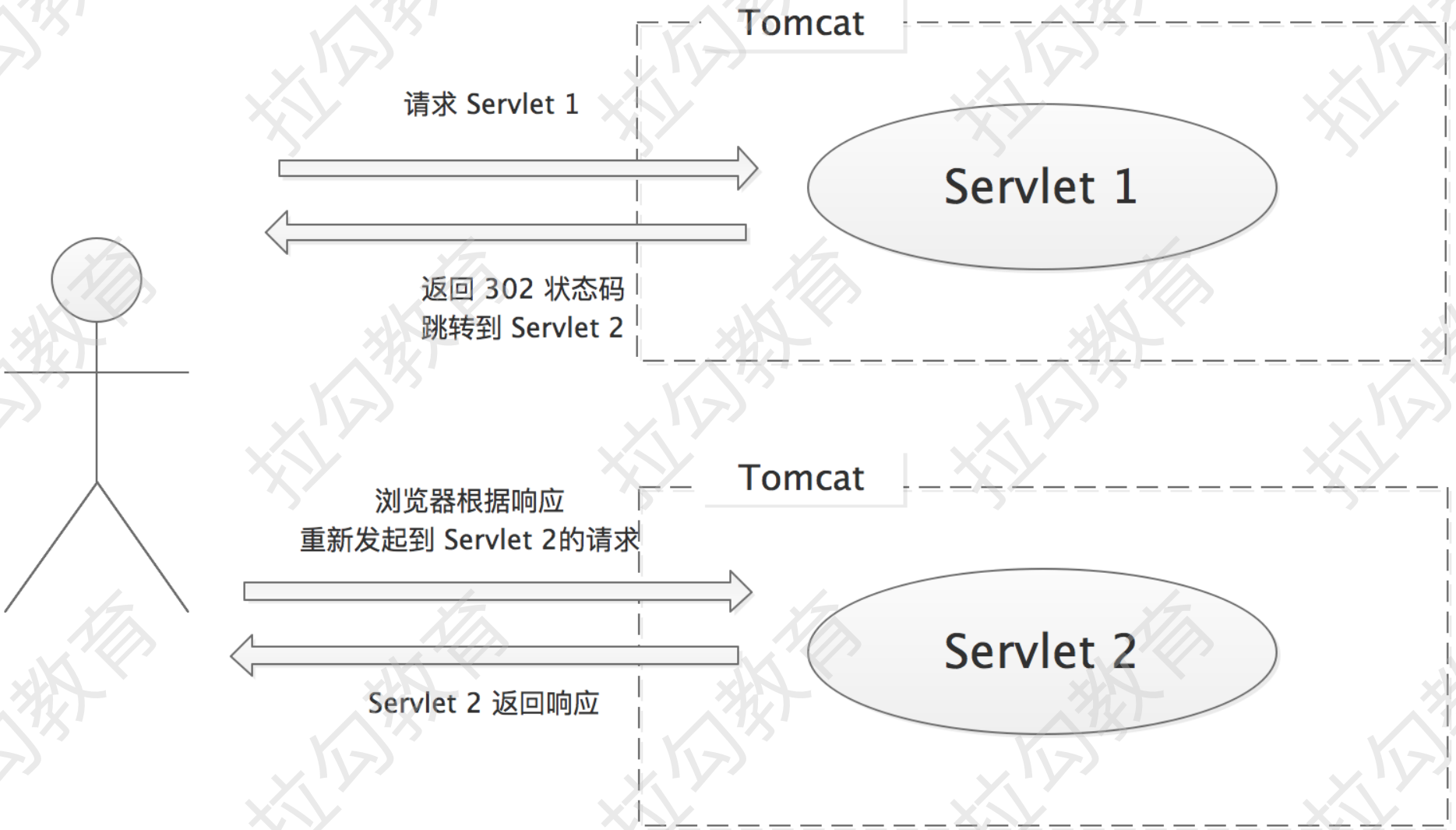
```
public void doGet(HttpServletRequest request,
        HttpServletResponse response){
    response.sendRedirect("跳转到的目标URL");
}
```

ApplicationDispatcherInstrumentation



ApplicationDispatcherInstrumentation

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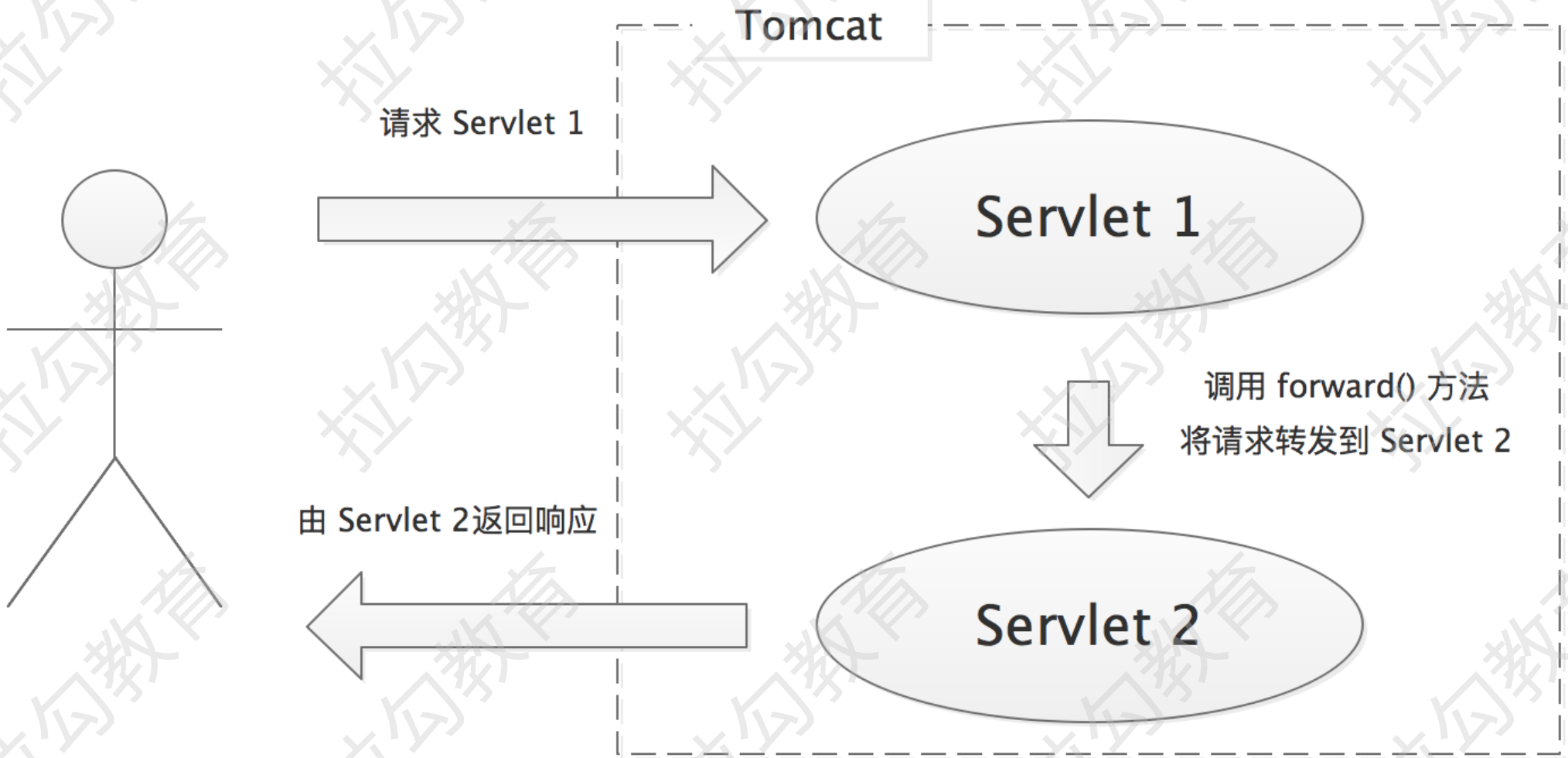
```
public void sendRedirect(String location, int status) {
  try {
    String locationUri = ...; // 获取 redirectUrl
    setStatus(status); // 状态码设置为302或是307
    setHeader("Location", locationUri);
    if (getContext().getSendRedirectBody()) { // 返回ResponseBody
      ...
    }
  } catch (IllegalArgumentException e) {
    setStatus("404");
  }
  setSuspended(true); // Cause the response to be finished
}
```

ApplicationDispatcherInstrumentation



ApplicationDispatcherInstrumentation

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```
public void doGet(HttpServletRequest request ,
      HttpServletResponse response){
  //获取请求转发器对象，该转发器的指向通过getRequestDisPatcher()的参数设置
  RequestDispatcher requestDispatcher =
        request.getRequestDispatcher("Servler2???");
  // 调用forward()方法，转发请求
  requestDispatcher.forward(request,response);
}
```

ApplicationDispatcherInstrumentation


```
public void onConstruct(EnhancedInstance objInst,
    Object[] allArguments) {
  // ApplicationDispatcher构造方法的第二个参数为跳转的目标地址，下图所示
  objInst.setSkyWalkingDynamicField(allArguments[1]);
}
```

ApplicationDispatcherInstrumentation

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```
public void onConstruct(EnhancedInstance objInst,
    Object[] allArguments) {
  //ApplicationDispatcher构造方法的第二个参数为跳转的目标地址，下图所示
  objInst.setSkyWalkingDynamicField(allArguments[1]);
}
```

```
public ApplicationDispatcher
    (Wrapper wrapper, String requestURI, String servletPath,
     String pathInfo, String queryString, HttpServletMapping mapping, String name) {
```

ApplicationDispatcherInstrumentation

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```
public void beforeMethod(EnhancedInstance objInst, Method method,
    Object[] allArguments, Class<?>[] argumentsTypes,
      MethodInterceptResult result) throws Throwable {
  AbstractSpan abstractTracingSpan =
      ContextManager.activeSpan();
  Map<String, String> eventMap = new HashMap<String, String>();
  eventMap.put("forward-url",
      objInst.getSkyWalkingDynamicField() == null ? "" :
      String.valueOf(objInst.getSkyWalkingDynamicField()));
  // 通过Log的方式记录将跳转URL
  abstractTracingSpan.log(System.currentTimeMillis(), eventMap);
  ContextManager.getRuntimeContext() // 记录forward标记
    .put(Constants.FORWARD_REQUEST_FLAG, true);
}
```

总结

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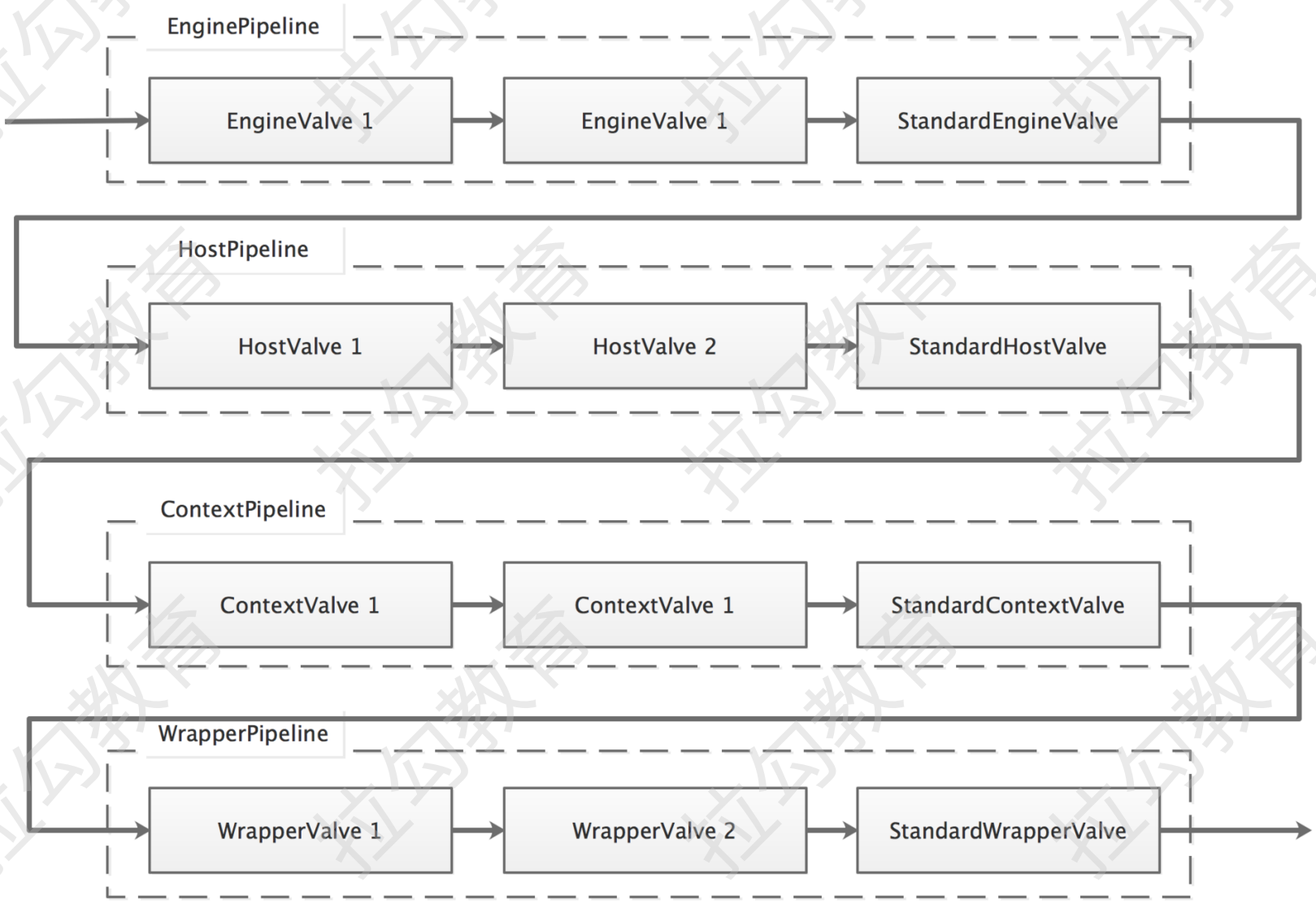
整个调用流程



Next：第15讲《Dubbo 插件核心剖析，Trace 是这样跨服务传播的》

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