Predicting Vulnerable Software Components

Stephan Neuhaus

Thomas Zimmermann
Andreas Zeller

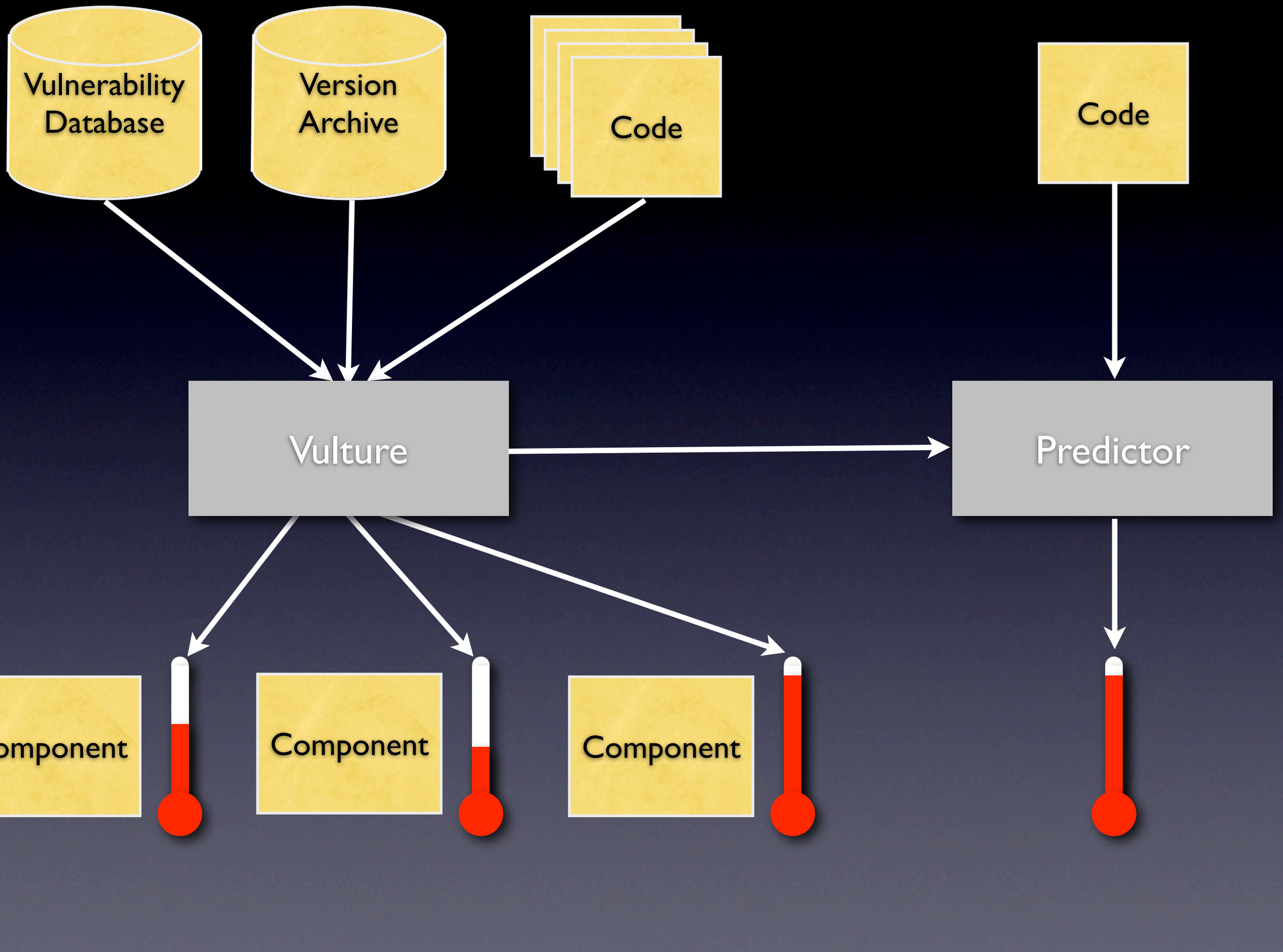
Security Advisory 2006-76

Title: XSS using outer windows Function object
Impact: High
Products: Firefox 2.0
Description: moz_bug_r_a4 demonstrated that the Function prototype regression described in bug 355161 could be exploited to bypass the protections against cross site script (XSS) injection, which could be used to steal credentials or sensitive data from arbitrary sites or perform destructive actions on behalf of a logged-in user.

Is this new component likely to be vulnerable?

What other components are vulnerable?

0 → Vulnerabilities


Vulnerability Database
Version Archive
Code
Code
Vulture
Predictor
Component
Component
Component

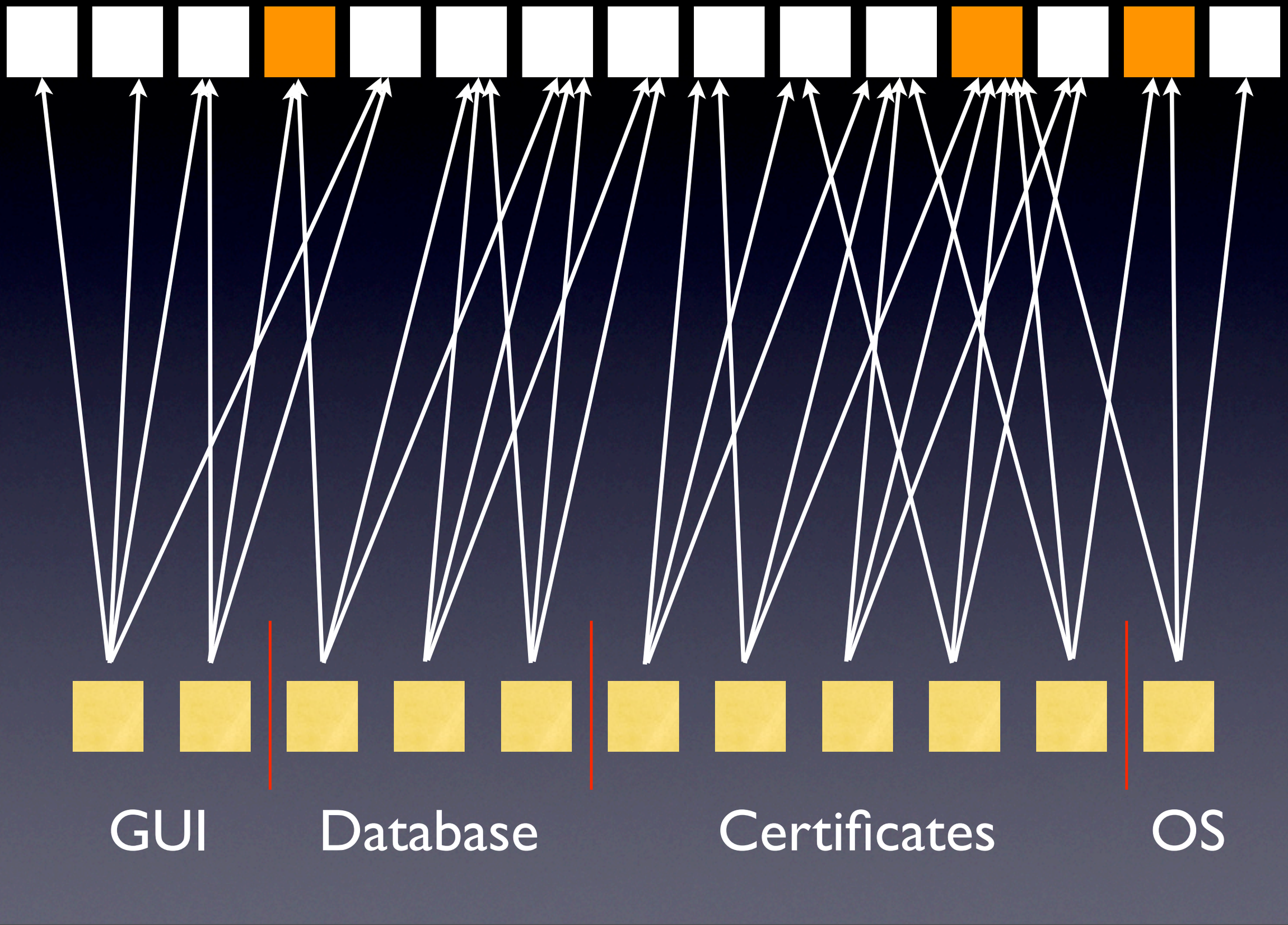
Programmer

Code Complexity

Look for features that are *invariant* under evolution

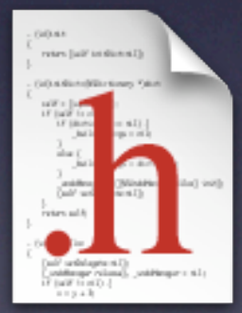
Language

Imports

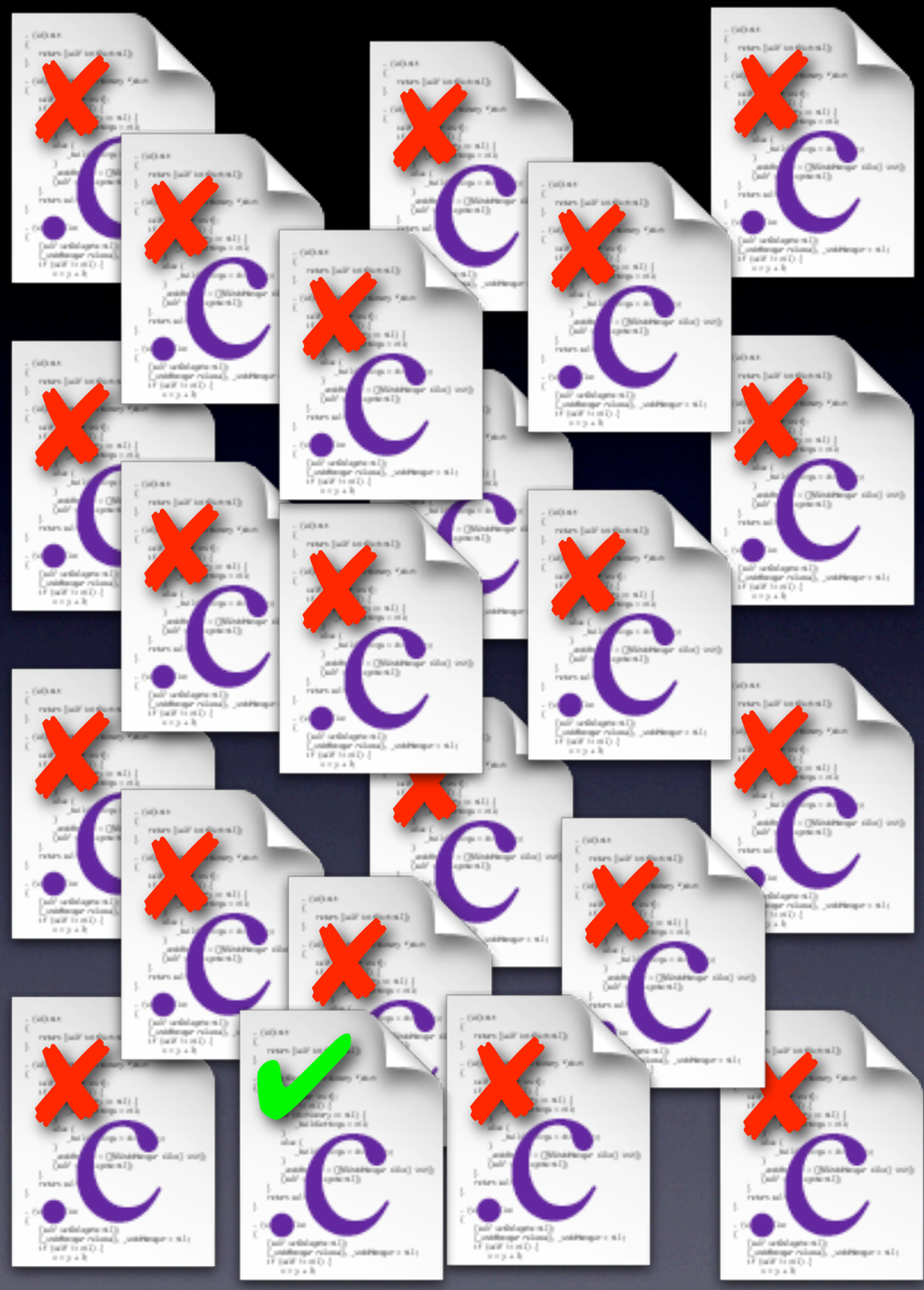


nsIContent.h

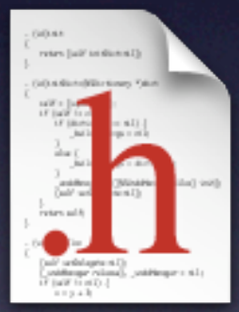
nsIContentUtils.h



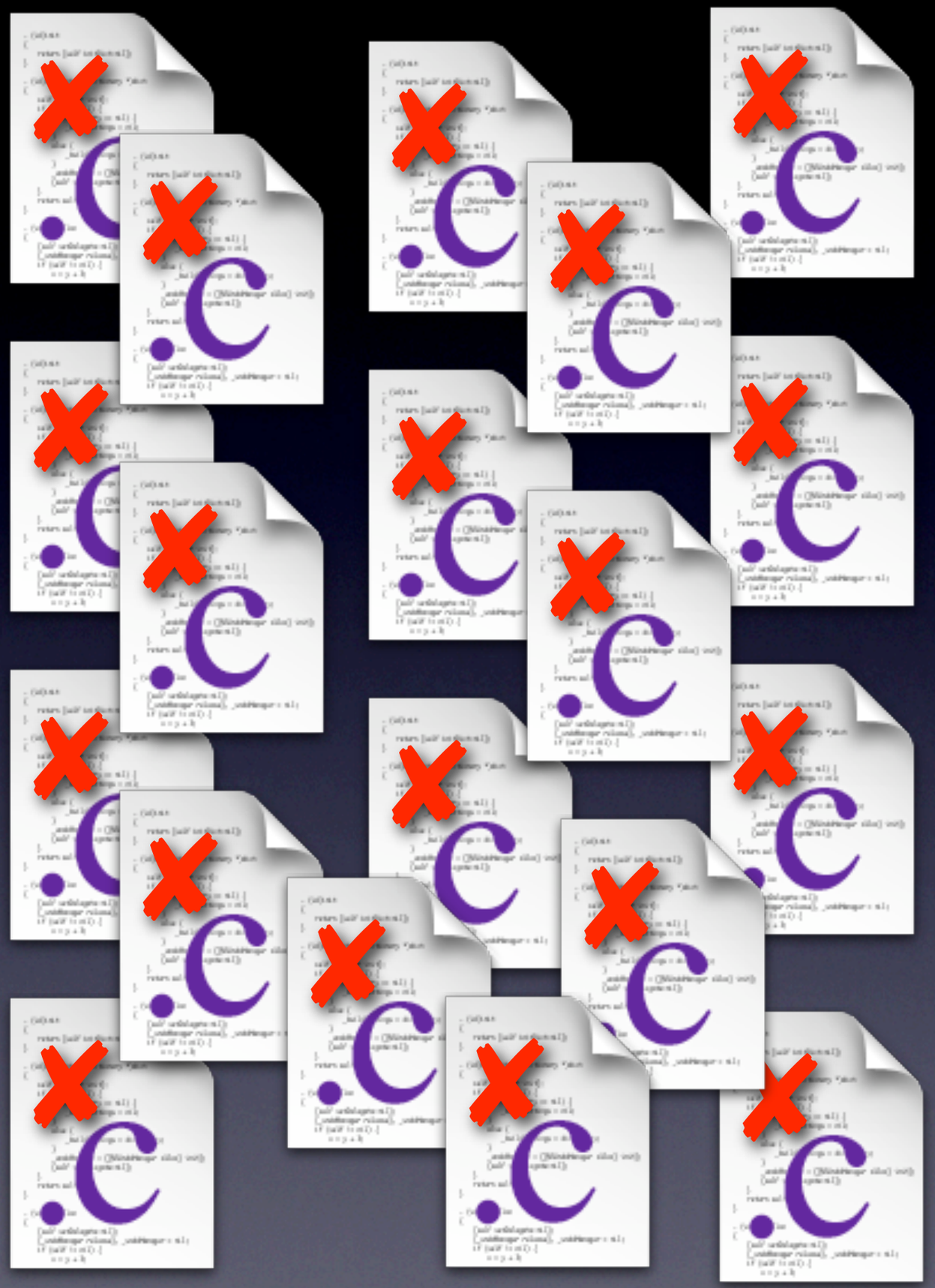
nsIScriptSecurityManager.h



nsIPrivateDOMEvent.h



nsReadableUtils.h



Research Questions

- How well do imports predict vulnerabilities?
- Can imports be used for classification (vulnerable or not) and for regression (number of vulnerabilities)?

Case Study: Mozilla

- CVS from January 4, 2007
- 14,368 C/C++ files
- 134 Security Advisories since January 2005
- Only 424 vulnerable components (4.05%)

⇒ *Prediction is challenging*

MFSA 2006-74: Mail header processing heap overflows

http://www.mozilla.org/security/announce/2006/mfsa2006-74.html

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  - Bugzilla
  - Tinderbox
  - Bonsai
  - LXR
- FAQs

Mozilla Foundation Security Advisory 2006-74

Title: Mail header processing heap overflows
Impact: Critical
Announced: December 19, 2006
Reporter: Georgi Guninski, David Bienvenu
Products: Thunderbird, SeaMonkey

Fixed in: Thunderbird 1.5.0.9
SeaMonkey 1.0.7

Description

Georgi Guninski reported that long Content-Type headers in external message bodies could cause a heap buffer overflow when processing mail headers. While working on that code David Bienvenu discovered a similar overflow could occur when processing long rfc2047-encoded headers.

Either overflow could be exploited to execute arbitrary code.

Workaround

None, upgrade to a fixed

References

https://bugzilla.mozilla.c
https://bugzilla.mozilla.c
CVE-2006-6505

gi?id=362213
gi?id=362512

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Last modified

Find: 2006-74

Done

CVS Log for mimeebod.cpp (1.27)

http://bonsai.mozilla.org/cvslog.cgi?file=mozilla%2Fmailnews%2Fmime%2Fsrc%

mozilla cvs

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CVS

mozilla

Rev A

1.27 bi
1.26 jo
1.25 ti
1.24 ge
1.23 ge
1.22 ca
1.21 ti
1.20 ca
1.19 ca
1.18 ge
1.17 ti
1.16 jg
1.14 w
1.13 rh
1.12 ric
1.11 al

CVS Log for comi18n.cpp (1.125)

http://bonsai.mozilla.org/cvslog.cgi?file=mozilla%2Fmailnews%2Fmime%2Fsrc%

keynote mask with shape

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Bonsai version 1.3.9

lxr Browse the source code as hypertext.
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blame Annotate the author of each line.
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CVS Log

mozilla/ mailnews/ mime/ src/ comi18

Log
fix 362512 issues
Bug 147697: asso

Rev	Author	Date	
1.125	bienvenu%nventure.com	2006-1	sr=mscott
1.124	smontagu%smontagu.org	2006-1	mail: generate_encodedwords(), output_carryoverlen
1.123	cbiesinger%web.de	2006-0	replacing them with *UTF16* ones
1.122	db48x%yahoo.com	2005-01-15 02:32	bug 226205: MailNews should use the newer nsIPrefService APIs instead of nsIPref patch by Mikael Parknert <mikael@parknert.se>, r=niel, sr=darin
1.121	darin%meer.net	2004-11-01 10:50	eliminating uses of deprecated nsComponentManager:: methods (bug 267040), r=bsmedberg
1.120	scott%scott-macgregor.org	2004-05-07 11:13	Bug #242065 - "My Name" from account is ignored when email contains "special chars", full name extracted from email address Patch by ch.ey@gmx.net sr=mscott
1.119	gerv%gerv.net	2004-04-17 11:33	Bug 236613: change to MPL/LGPL/GPL tri-license.
1.118	darin%meer.net	2004-02-19 17:53	landing patch for bug 234864 "string branch landing resulted in large spike in heap allocations (bmd:A metric)" r+sr=dbaron this patch also introduces nsTFixedString and removes CBufDescriptor.
1.117	jshin%mailaps.org	2003-06-12 14:57	bug 167265 : add to necko Content-Disposition header handling per RFC 2231 (with fallbacks to RFC 2047 and raw 8bit chars in leOriginCharset!) necessary for
1.116	alecf%flett.org		
1.115	alecf%netscape.com		
1.114	alecf%netscape.com		
1.113	alecf%netscape.com		

Find: mask

Done

Aquamacs – mimeebod.h

```
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 * the terms of any
 *
 * ***** END LICENSE

#ifndef _MIMEEBOD_H_
#define _MIMEEBOD_H_

#include "mimeobj.h"

/* The MimeExternalB
   (This is not to b
   handler for appli
   handlers.)
 */

typedef struct MimeE
typedef struct MimeE

struct MimeExternalB
  MimeObjectClass ob
};

extern MimeExternalB

struct MimeExternalB
  MimeObject object;
  MimeHeaders *hdrs;

  char *body;
};

#endif /* _MIMEEBOD_
```

-:-- mimeebod.h
Wrong type argument:

Aquamacs – mimeebod.cpp

```
 * ***** END LICENSE BLOCK ***** */
#include "nsCOMPtr.h"
#include "nsIURL.h"
#include "mimeebod.h"
#include "prmem.h"
#include "nsCRT.h"
#include "plstr.h"
#include "prlog.h"
#include "prio.h"
#include "nsFileSpec.h"
#include "nsEscape.h"
#include "msgCore.h"
#include "nsMimeStringResources.h"
#include "mimemoz2.h"

#define MIME_SUPERCLASS mimeObjectClass
MimeDefClass(MimeExternalBody, MimeExternalBodyClass,
             mimeExternalBodyClass, &MIME_SUPERCLASS);

#ifdef XP_MACOSX
extern MimeObjectClass mimeMultipartAppleDoubleClass;
#endif

static int MimeExternalBody_initialize (MimeObject *);
static void MimeExternalBody_finalize (MimeObject *);
static int MimeExternalBody_parse_line (const char *, PRInt32, MimeObject *);
static int MimeExternalBody_parse_eof (MimeObject *, PRBool);
static PRBool MimeExternalBody_displayable_inline_p (MimeObjectClass *clazz,
                                                     MimeHeaders *hdrs);

#if 0
#if defined(DEBUG) && defined(XP_UNIX)
static int MimeExternalBody_debug_print (MimeObject *, PRFileDesc *, PRInt32);
#endif
#endif /* 0 */

static int
MimeExternalBodyClassInitialize(MimeExternalBodyClass *clazz)
```

-:-- mimeebod.cpp 13% (37,0) (C/l Abbrev Fill)
Undo!

Aquamacs – comi18n.h

```
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 * and other provisio
 * the provisions abo
 * the terms of any o
 *
 * ***** END LICENSE
#ifndef _COMI18N_LOAD
#define _COMI18N_LOAD

#include "msgCore.h"

//#ifndef kMIME_ENCOD
//#define kMIME_ENCOD
//#endif

#ifndef kMAX_CSNAME
#define kMAX_CSNAME 6
#endif

class nsIUnicodeDecod
class nsIUnicodeEncod
class nsIStringCharse

#ifdef __cplusplus
extern "C" {
#endif /* __cplusplus

/**
 * Decode MIME header
 * Uses MIME_ConvertC
 *
 *
 * @param header
 * @param default_cha
8 8bit data
 * @param override_ch
ny charset labeling o
```

-:-- comi18n.h
Wrong type argument:

Aquamacs – comi18n.cpp

```
static const char hexdigits[] = "0123456789ABCDEF";

static PRInt32
intlmime_encode_q(const unsigned char *src, PRInt32 srcsize, char *out)
{
  const unsigned char *in = (unsigned char *) src;
  const unsigned char *end = in + srcsize;
  char *head = out;

  for (; in < end; in++) {
    if (NO_Q_ENCODING_NEEDED(*in)) {
      *out++ = *in;
    }
    else if (*in == ' ') {
      *out++ = '_';
    }
    else {
      *out++ = '=';
      *out++ = hexdigits[*in >> 4];
      *out++ = hexdigits[*in & 0xF];
    }
  }
  *out = '\0';
  return (out - head);
}

static void
encodeChunk(const unsigned char* chunk, char* output)
{
  register PRInt32 offset;

  offset = *chunk >> 2;
  *output++ = basis_64[offset];

  offset = ((*chunk << 4) & 0x30) + (*(chunk+1) >> 4);
  *output++ = basis_64[offset];
```

-:-- comi18n.cpp 13% (80,0) (C++/l Abbrev Fill)

MFSA 2006-74: Mail header processing heap overflows

http://www.mozilla.org/security/announce/2006/mfsa2006-74.html

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Either overflow could be exploited to execute arbitrary code.

Workaround

None, upgrade to a fixed version immediately.

References

https://bugzilla.mozilla.org/show_bug.cgi?id=362213
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CVE-2006-6505

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http://bonsai.mozilla.org/cvslog.cgi?file=mozilla%2Fmailnews%2Fmime%2Fsrc%

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Bonsai version 1.3.9

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mozilla/ mailnews/ mime/ src/ mimeebod.cpp (1.27)

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CVS Log

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RSS Get an RSS version of this page.
graph View the revision history as a graph

Rev	Author	Date	Log
1.125	bienvenu%nventure.com	2006-12-01 11:24	fix 362512 issues with rfc2047 encoding, sr=mscott
1.124	smontagu%smontagu.org	2006-10-18 00:49	Bug 147697: assertion every time I send mail: generate_encodedwords(), output_carryoverlen must be > 0, r=ducarroz, sr=bienvenu
1.123	cbiesinger%web.de	2006-02-03 06:18	bug 183156 remove *UCS2* functions, replacing them with *UTF16* ones r+sr=darin
1.122	db48x%yahoo.com	2005-01-15 02:32	bug 226005: MailNews should use the newer nsIPrefService APIs instead of nsIPref patch by Mikael Parknert <mikael@parknert.se>, r=niel, sr=darin
1.121	darin%meer.net	2004-11-01 10:50	eliminating uses of deprecated nsComponentManager:: methods (bug 267040), r=bsmedberg
1.120	scott%scott-macgregor.org	2004-05-07 11:13	Bug #242065 --> "My Name" from account is ignored when email contains "special chars", full name extracted from email address Patch by ch.ey@gmx.net sr=mscott
1.119	gerv%gerv.net	2004-04-17 11:33	Bug 236613: change to MPL/LGPL/GPL tri-license.
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1.116	alecf%flett.org	1999-11-05	
1.115	alecf%netscape.com	1999-10-13	
1.114	alecf%netscape.com	1999-10-06	
1.113	alecf%netscape.com	1999-09-04	
1.112	alecf%netscape.com	1999-06-15	
1.111	alecf%netscape.com	1999-05-28	
1.110	alecf%netscape.com	1999-05-04	
1.109	alecf%netscape.com	1999-04-12	
1.108	alecf%netscape.com	1999-03-13	
1.107	alecf%netscape.com	1999-02-12	
1.106	alecf%netscape.com	1999-01-29	
1.105	alecf%netscape.com	1999-01-15	
1.104	alecf%netscape.com	1998-12-04	
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1.24	alecf%netscape.com	1998-11-12	
1.23	alecf%netscape.com	1998-11-12	
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1.16	alecf%netscape.com	1998-11-12	
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1.13	alecf%netscape.com	1998-11-12	
1.12	alecf%netscape.com	1998-11-12	
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* ***** END LICENSE

#ifndef _MIMEEBOD_H_
#define _MIMEEBOD_H_

#include "mimeobj.h"

/* The MimeExternalB
   (This is not to b
   handler for appli
   handlers.)
 */

typedef struct MimeE
typedef struct MimeE

struct MimeExternalB
  MimeObjectClass ob
};

extern MimeExternalB

struct MimeExternalB
  MimeObject object;
  MimeHeaders *hdrs;

  char *body;
};

#endif /* _MIMEEBOD_
```

-:-- **mimeebod.h**
Wrong type argument:

Aquamacs – mimeebod.cpp

```
 * ***** END LICENSE BLOCK ***** */
#include "nsCOMPtr.h"
#include "nsIURL.h"
#include "mimeebod.h"
#include "prmem.h"
#include "nsCRT.h"
#include "plstr.h"
#include "prlog.h"
#include "prio.h"
#include "nsFileSpec.h"
#include "nsEscape.h"
#include "msgCore.h"
#include "nsMimeStringResources.h"
#include "mimemoz2.h"

#define MIME_SUPERCLASS mimeObjectClass
MimeDefClass(MimeExternalBody, MimeExternalBodyClass,
             mimeExternalBodyClass, &MIME_SUPERCLASS);

#ifdef XP_MACOSX
extern MimeObjectClass mimeMultipartAppleDoubleClass;
#endif

static int MimeExternalBody_initialize (MimeObject *);
static void MimeExternalBody_finalize (MimeObject *);
static int MimeExternalBody_parse_line (const char *, PRInt32, MimeObject *);
static int MimeExternalBody_parse_eof (MimeObject *, PRBool);
static PRBool MimeExternalBody_displayable_inline_p (MimeObjectClass *clazz,
                                                     MimeHeaders *hdrs);

#if 0
#if defined(DEBUG) && defined(XP_UNIX)
static int MimeExternalBody_debug_print (MimeObject *, PRFileDesc *, PRInt32);
#endif
#endif /* 0 */

static int
MimeExternalBodyClassInitialize(MimeExternalBodyClass *clazz)
```

-:-- **mimeebod.cpp** 13% (37,0) (C/l Abbrev Fill)
Undo!

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```
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#ifndef _COMI18N_LOAD
#define _COMI18N_LOAD

#include "msgCore.h"

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//#define kMIME_ENCOD
//#endif

#ifndef kMAX_CSNAME
#define kMAX_CSNAME 6

class nsIUnicodeDecod
class nsIUnicodeEncod
class nsIStringCharse

#ifdef __cplusplus
extern "C" {
#endif /* __cplusplus

/**
 * Decode MIME header
 * Uses MIME_ConvertC
 *
 *
 * @param header
 * @param default_cha
 * 8bit data
 * @param override_ch
 * charset labeling o
```

-:-- **comi18n.h**
Wrong type argument:

Aquamacs – comi18n.cpp

```
static const char hexdigits[] = "0123456789ABCDEF";

static PRInt32
intlmime_encode_q(const unsigned char *src, PRInt32 srcsize, char *out)
{
  const unsigned char *in = (unsigned char *) src;
  const unsigned char *end = in + srcsize;
  char *head = out;

  for (; in < end; in++) {
    if (NO_Q_ENCODING_NEEDED(*in)) {
      *out++ = *in;
    }
    else if (*in == ' ') {
      *out++ = '_';
    }
    else {
      *out++ = '=';
      *out++ = hexdigits[*in >> 4];
      *out++ = hexdigits[*in & 0xF];
    }
  }
  *out = '\0';
  return (out - head);
}

static void
encodeChunk(const unsigned char* chunk, char* output)
{
  register PRInt32 offset;

  offset = *chunk >> 2;
  *output++ = basis_64[offset];

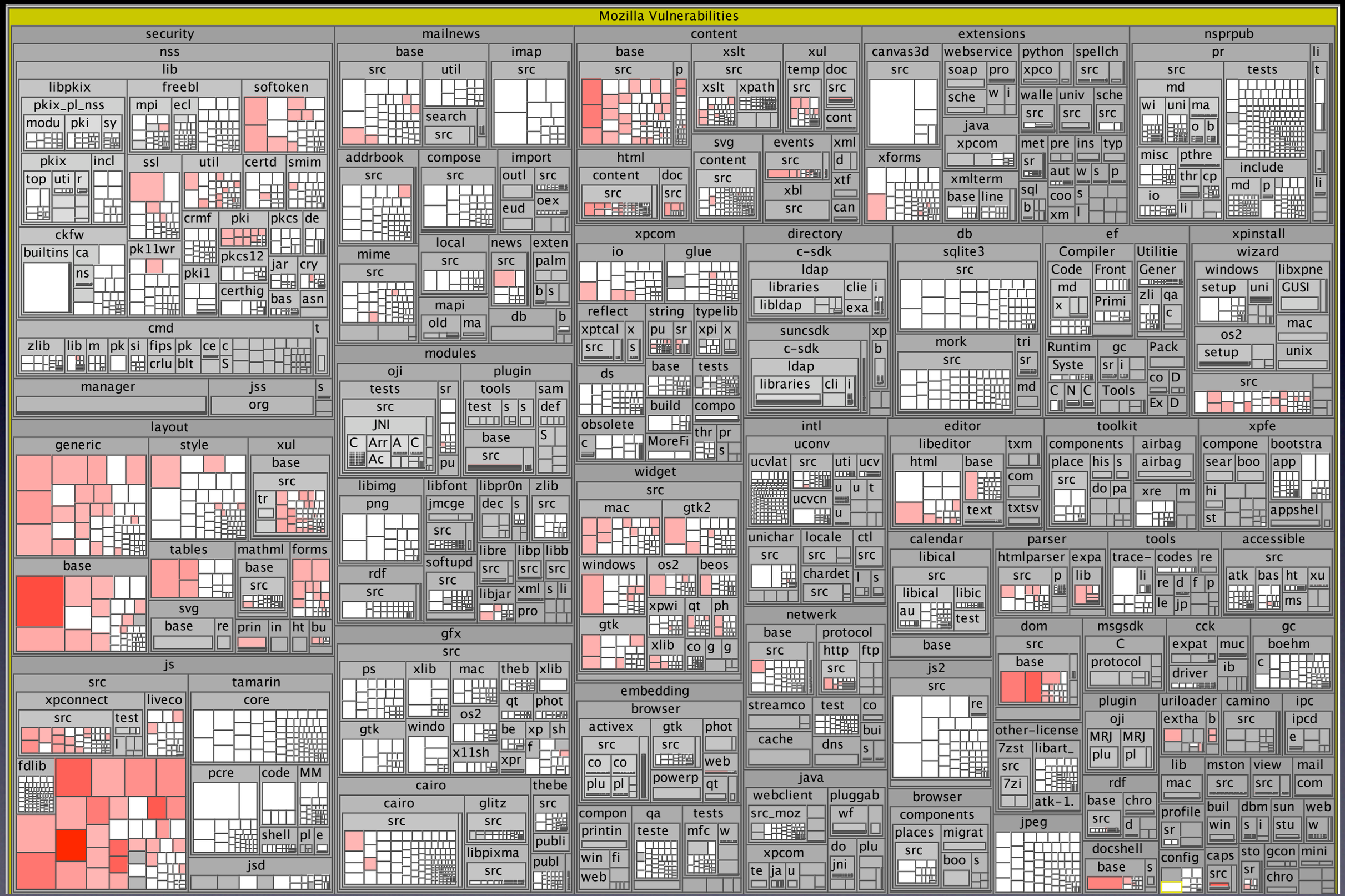
  offset = ((*chunk << 4) & 0x30) + (*(chunk+1) >> 4);
  *output++ = basis_64[offset];
```

-:-- **comi18n.cpp** 13% (80,0) (C++/l Abbrev Fill)

10,452 components in Mozilla

424 vulnerable components

4.05%


Mozilla Vulnerabilities
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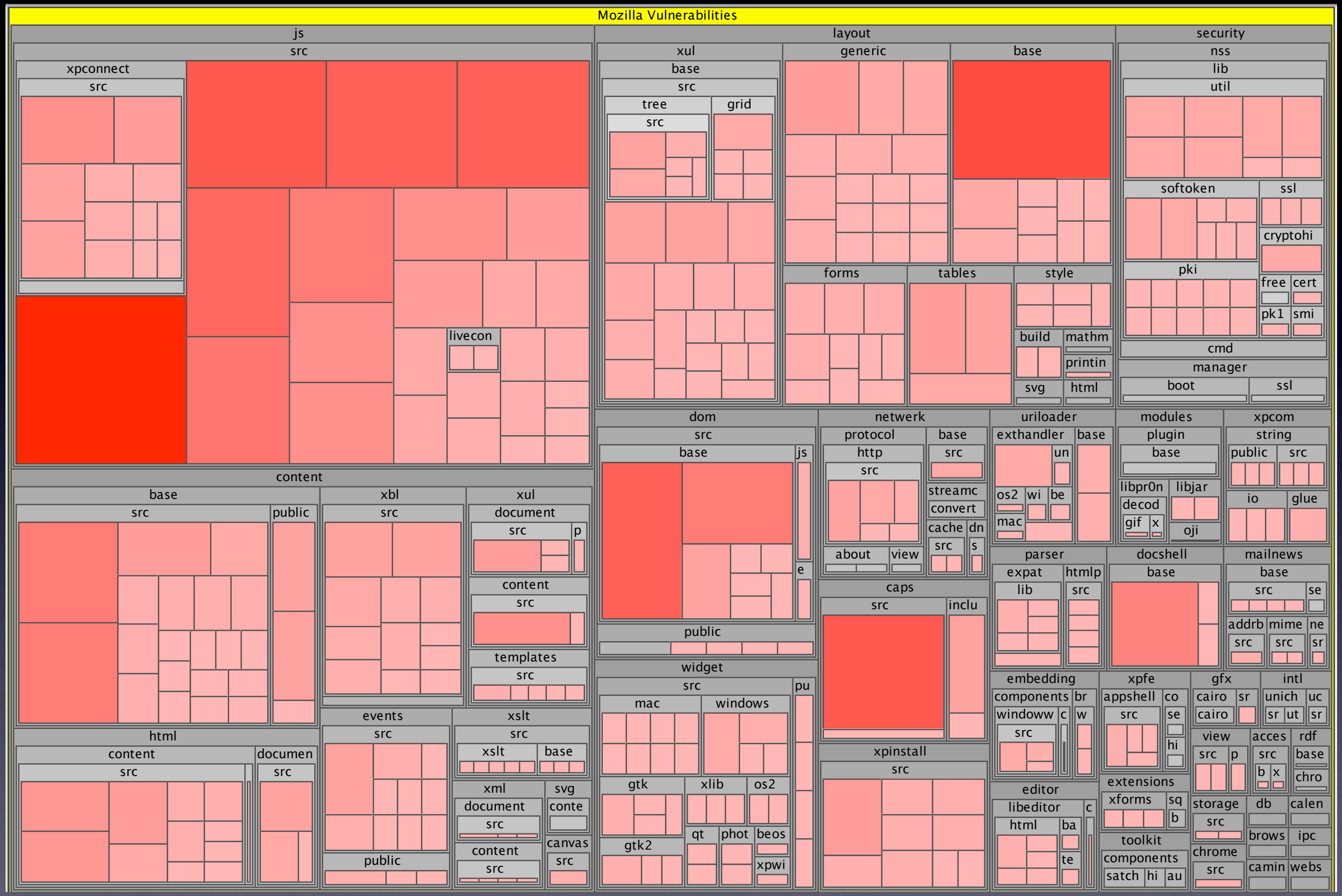
Mozilla Vulnerabilities
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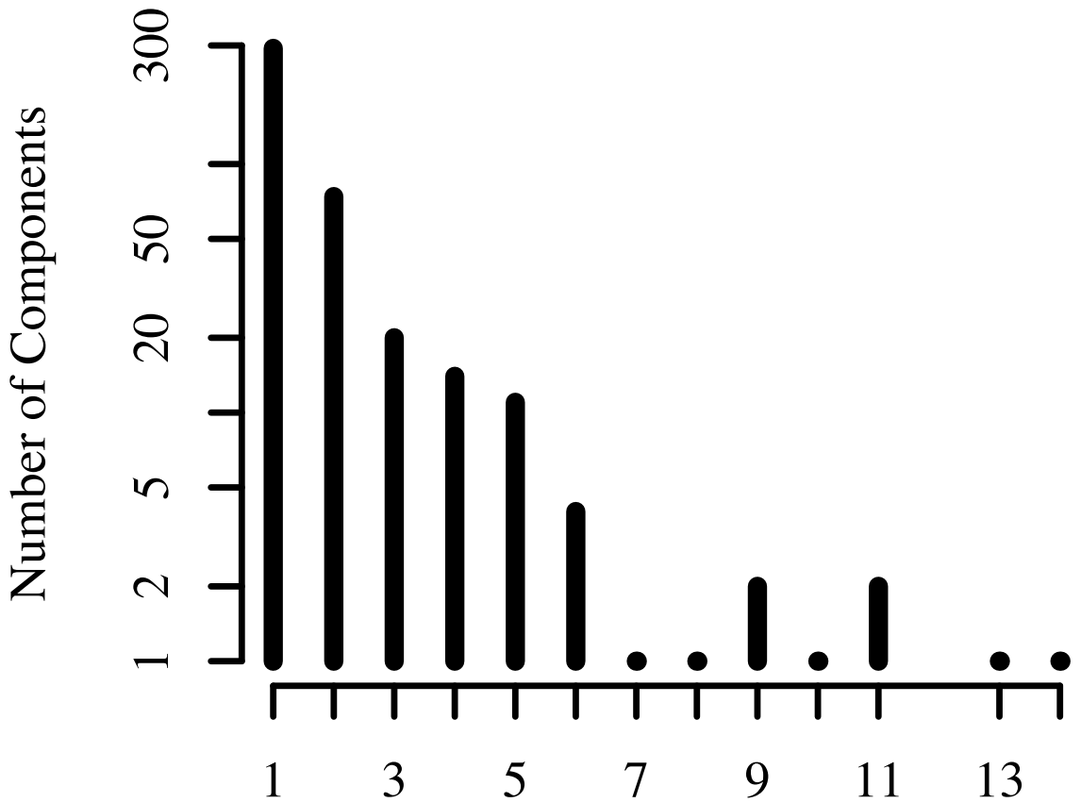
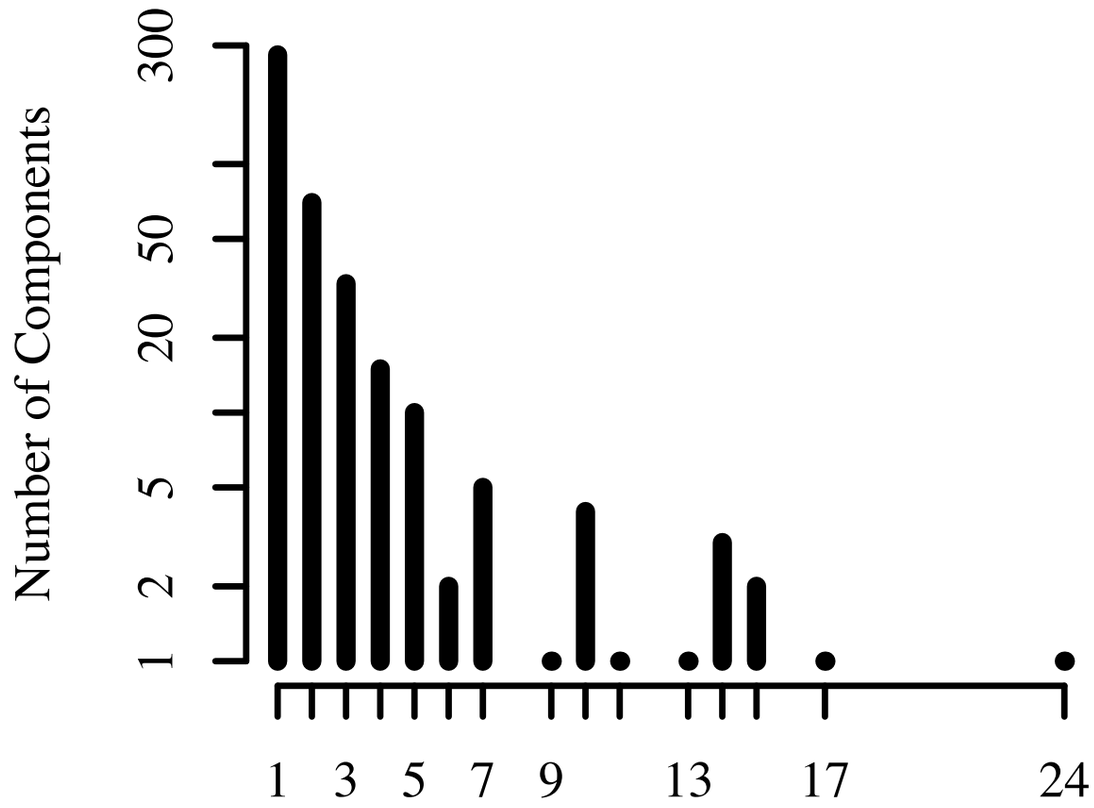
Distribution of MFSAs



Distribution of Bug Reports

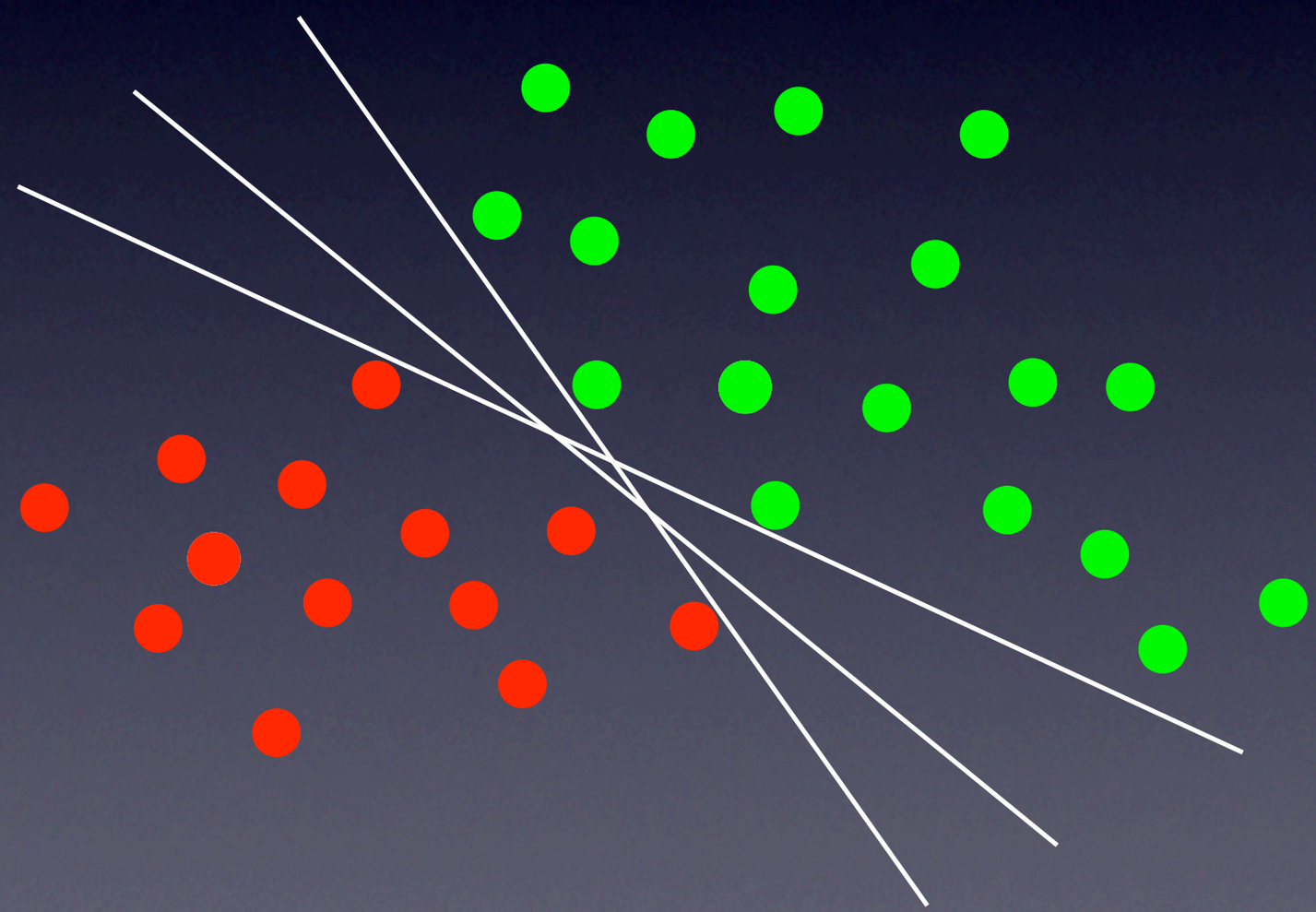


Imports

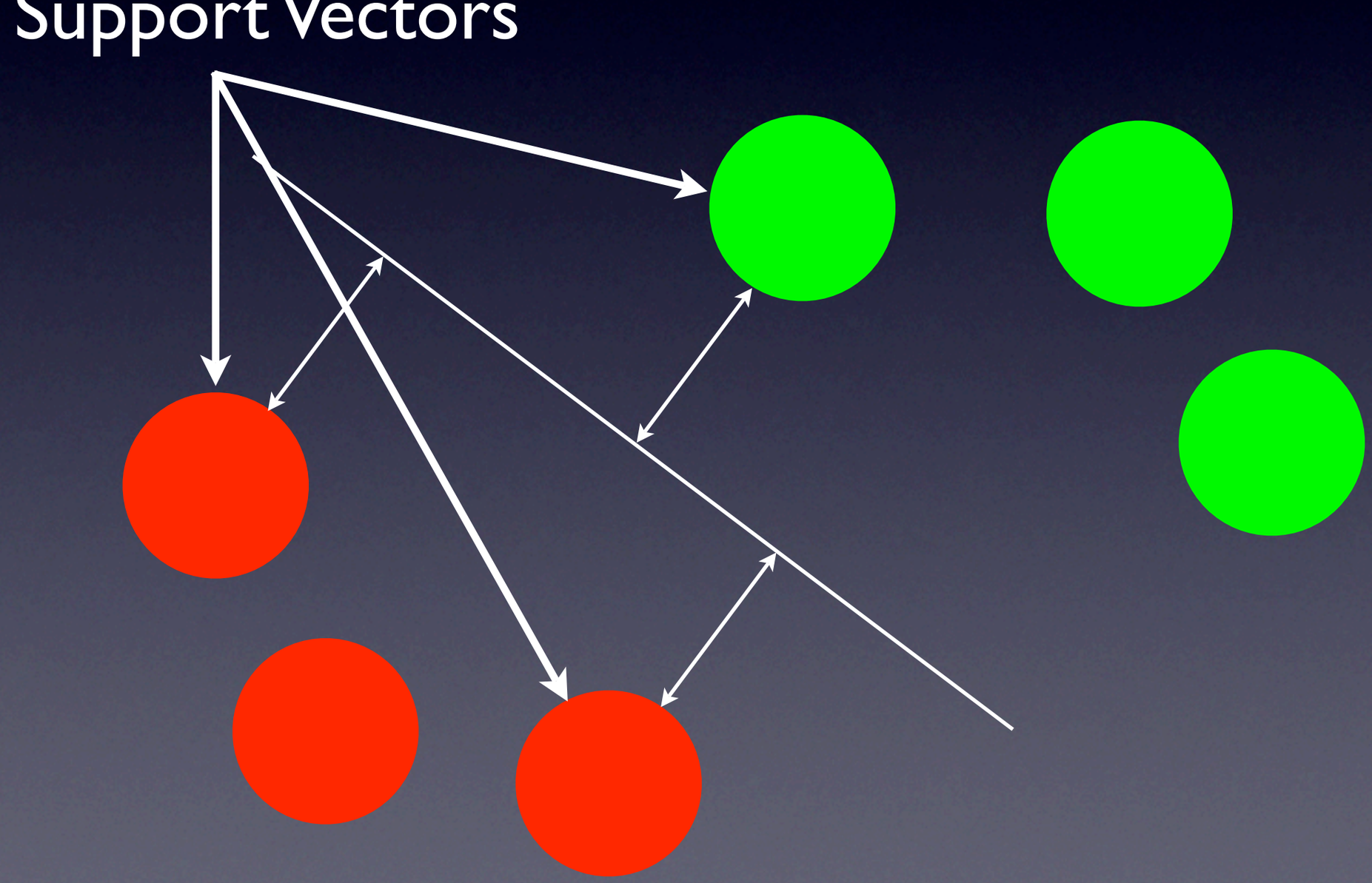
- 9,066 imports
- 79,541 import relations (*x* imports *y*)
- Takes about five minutes to compute

Results soon

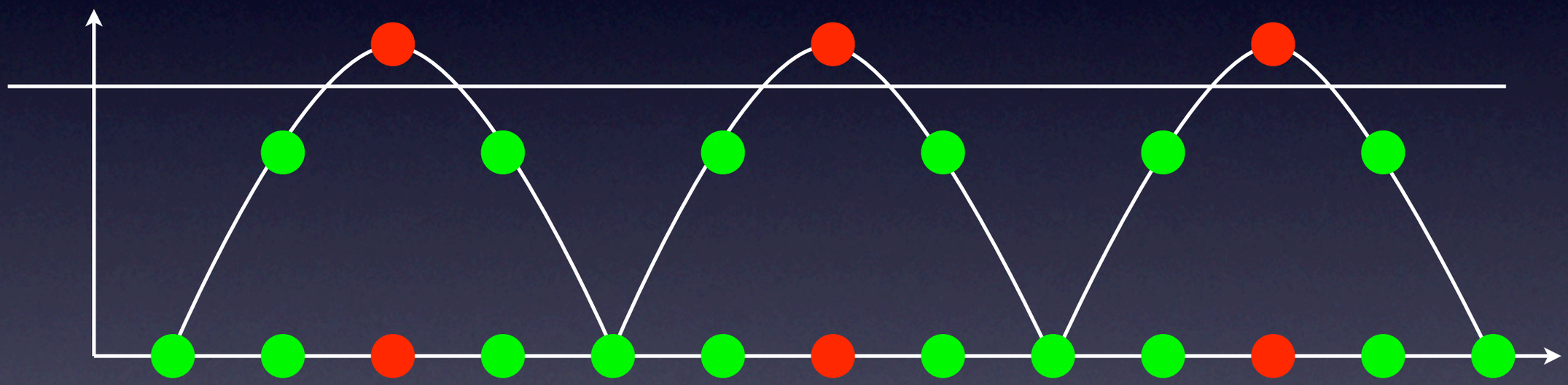
Support Vector Machines



Support Vector Machines



Support Vector Machines

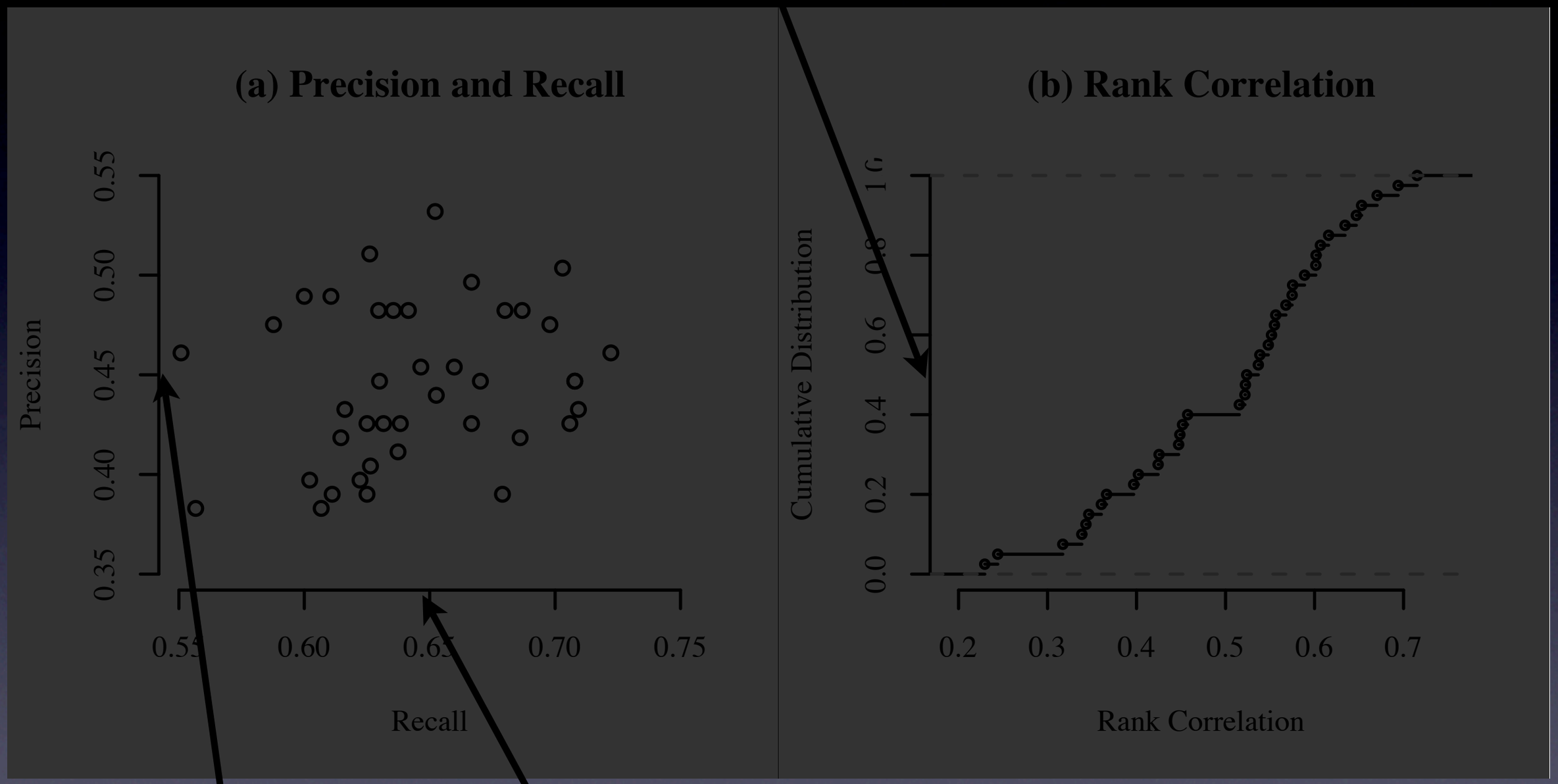


Results Now!

Experiments

- 40 random splits
  6,968 rows in training set, 3,484 rows in validation set
- Classification
  Train SVM, compute recall and precision
- Regression
  Train SVM, compute rank correlation on top 1%
- SVM: linear kernel with default parameters
  R implementation (up to 10GB of main memory)

moderately strong correlation (mostly significant at p < 0.01)



2/3 of all vulnerable components detected

45% (about 1/2) of predictions correct

Similar Results for Bugs

Packages + Import relationships

(Schröter et al, ISESE 2006)

Precision: 66.7% Recall: 69.4%

Binaries + Dependencies

(Zimmermann/Nagappan @ Microsoft Research, 2006)

Precision: 64.4% Recall: 75.3%

Predicted Rank	Component	Actual Rank
1	nsDOMClassInfo	3
2	SGridRowLayout	95
3	xpcprivate	6
4	jsxml	2
5	nsGenericHTMLElement	8
6	jsgc	3
7	nsISEnvironment	12
8	jsfun	1
9	nsHTMLLabelElement	18
10	nsHttpTransaction	35