KNOWING YOU'RE SECURE

Understanding and bypassing Windows Heap Protection

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IMMUNITY Security Research

Who am I?

- Senior Security Researcher and Regional Manager at Immunity, Inc.
- Research and Development of reliable Heap Overflow exploitation for CANVAS attack framework
- Leading Immunity's latest project: the VulnDev oriented Immunity Debugger

Software companies now understand the value of security

- Over the past few years regular users have become more aware of security problems
- As a result 'security' has become a valuable and marketable asset
- Recognizing this, the computer industry has invested in both hardware and software security improvements

And so... heap protection has been introduced

- Windows XP SP2, Windows 2003 SP1 and Vista introduced different heap validity checks to prevent unlink() write4 primitives
- Similar technologies are in place in glibc in Linux
- There are no generic ways to bypass the new heap protection mechanisms
  - The current approaches have a lot of requirements: **How do we meet these requirements?**

XP SP2 makes our work hard

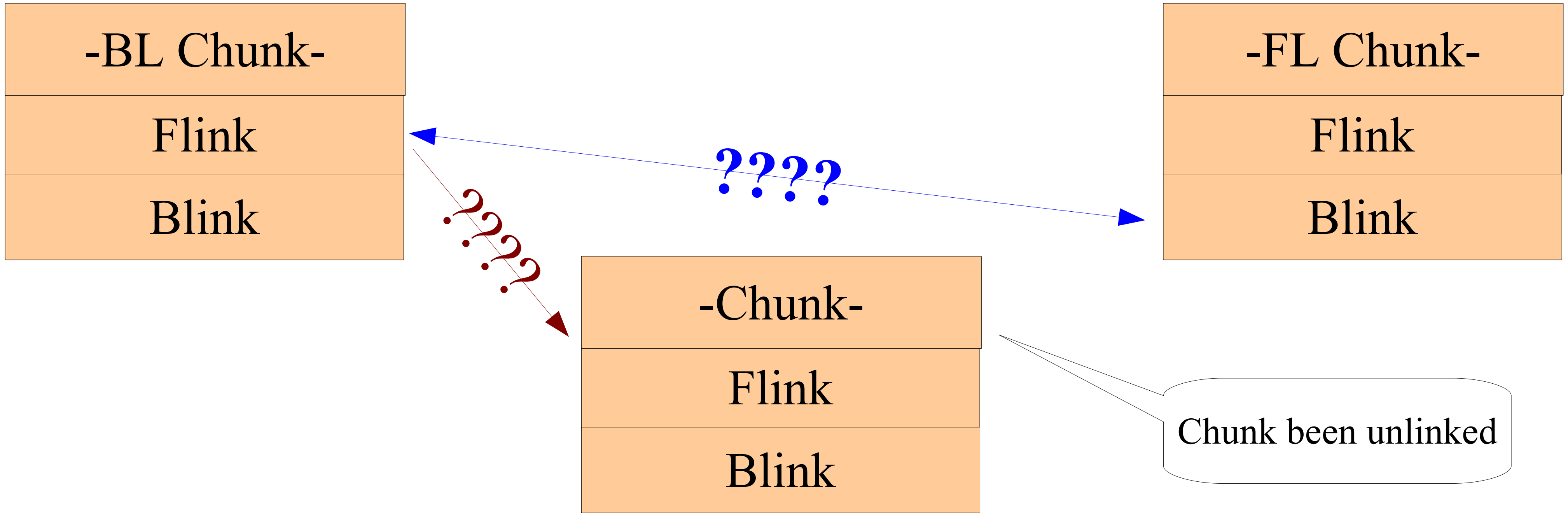
- Windows XP SP2 introduced the first obvious protection mechanism
  - unlinking checks:

```
blink = chunk->blink
flink = chunk->flink

if blink->flink == flink->blink
 and blink->flink == chunk
```

and harder...

- Windows XP SP2 introduced the first obvious protection mechanism
  - unlinking checks:



XP SP2 (and Vista) introduced more heap protections

- Low Fragmentation Heap Chunks:

  metadata semi-encryption

```
subsegment  = chunk->subsegmentcode
subsegment ^= RtlpLFHKey
subsegment ^= Heap
subsegment ^= chunk >> 3
```

Vista heap algorithm changes make unlink() unlikely

– Vista Heap Chunks:

metadata semi-encryption and integrity check

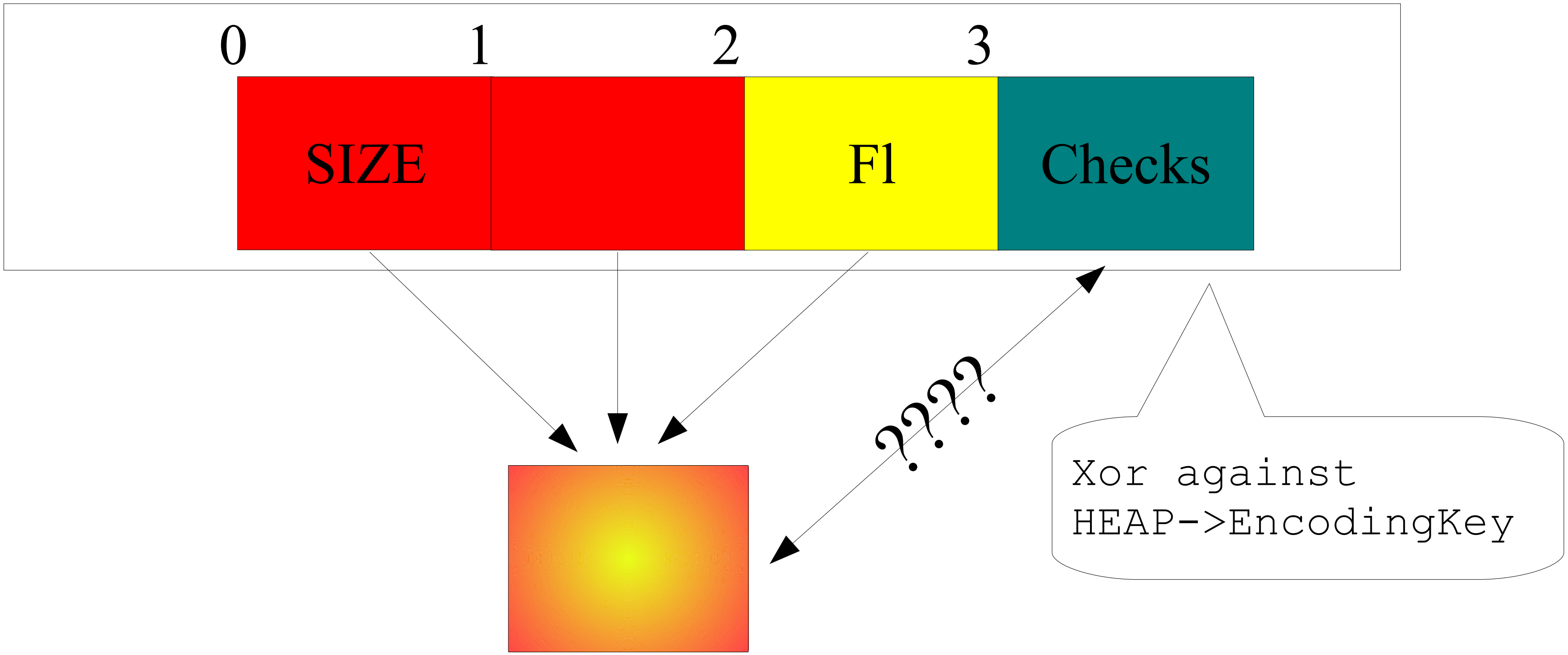
```
*(chunk)      ^=   HEAP->EncodingKey
checksum       =   (char) *( chunk + 1)
checksum      ^=   (char) *( chunk )
checksum      ^=   (char) *(chunk + 2)

if checksum == chunk->Checksum
```

Checksum makes it hard to predict and control the header

- Vista Heap Chunks:

  metadata semi-encryption and integrity check



Other protections in Vista are not heap specific

- Other protection mechanisms:
  - ASLR of pages
  - DEP (Hardware NX)
  - Safe Pointers
  - SafeSEH (stack)
  - etc.

A lot of excellent work has been done to bypass heap protections

- Taking advantage of Freelist[0] split mechanism (“*Exploiting Freelist[0] on XP SP2”* by Brett Moore)
- Taking advantage of Single Linked List unlink on the Lookaside (Oded Horovitz and Matt Connover)
- Heap Feng Shui in Javascript (Alexander Sotirov)

We no longer use heap algorithms to get write4 primitives

- Generic heap exploitation approaches are obsolete. There is no more easy write4.
  - Sinan: "*I can make a strawberry pudding with so many prerequisites*"
- Application specific techniques are needed
  - We use a methodology based on understanding and controlling the algorithm to position data carefully on the heap

We have been working on this methodology for years

- All good heap overflow exploits have been in careful control of the heap for years to reach the maximum amount of reliability
- We now also attack not the heap metadata, but the heap data itself
  - Because our technique is specific to each program, generic heap protections can not prevent it
- Immunity Debugger contains powerful new tools to aid this process

Previous exploits already carefully crafted the heap

- Spooler Exploit:
  - Multiple Write4 with a combination of the Lookaside and the FreeList
- MS05_025:
  - Softmemleaks to craft the proper layout for two Write4 in a row
- Any other reliable heap overflow
- These still used write4s from the heap algorithms themselves!

To establish deterministic control over the Heap you need

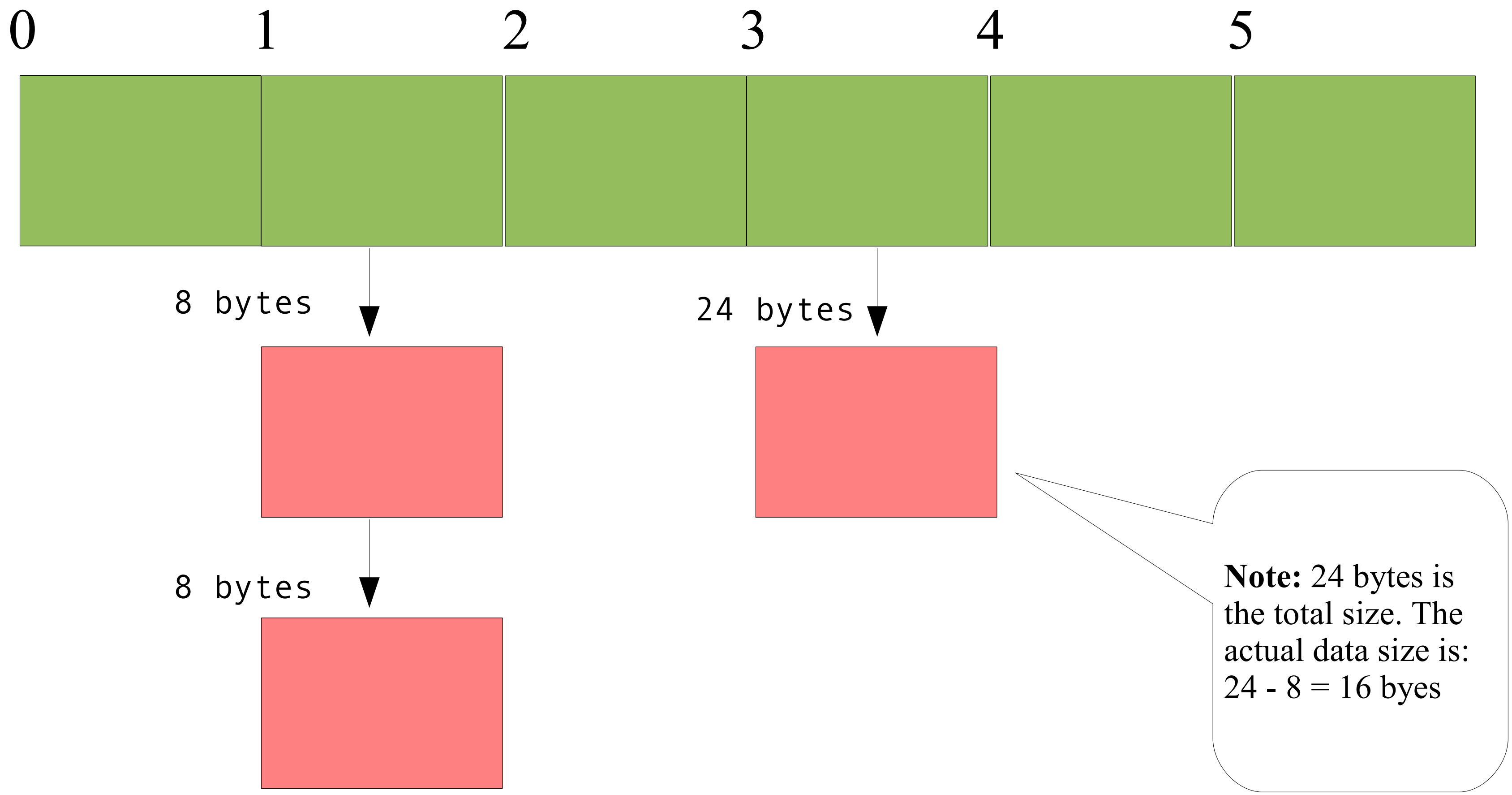
- Understanding of the allocation algorithm
- Understanding of the layout you are exploiting
- A methodology to control the layout
- The proper tools to understand and control the allocation pattern of a process

The heap, piece by piece

- Understanding the algorithm
  - Structures where chunks are held:
    - Lookaside
    - FreeList
- Understanding Chunk Behaviour
  - Coalescing of Chunks
  - Splitting of Chunks

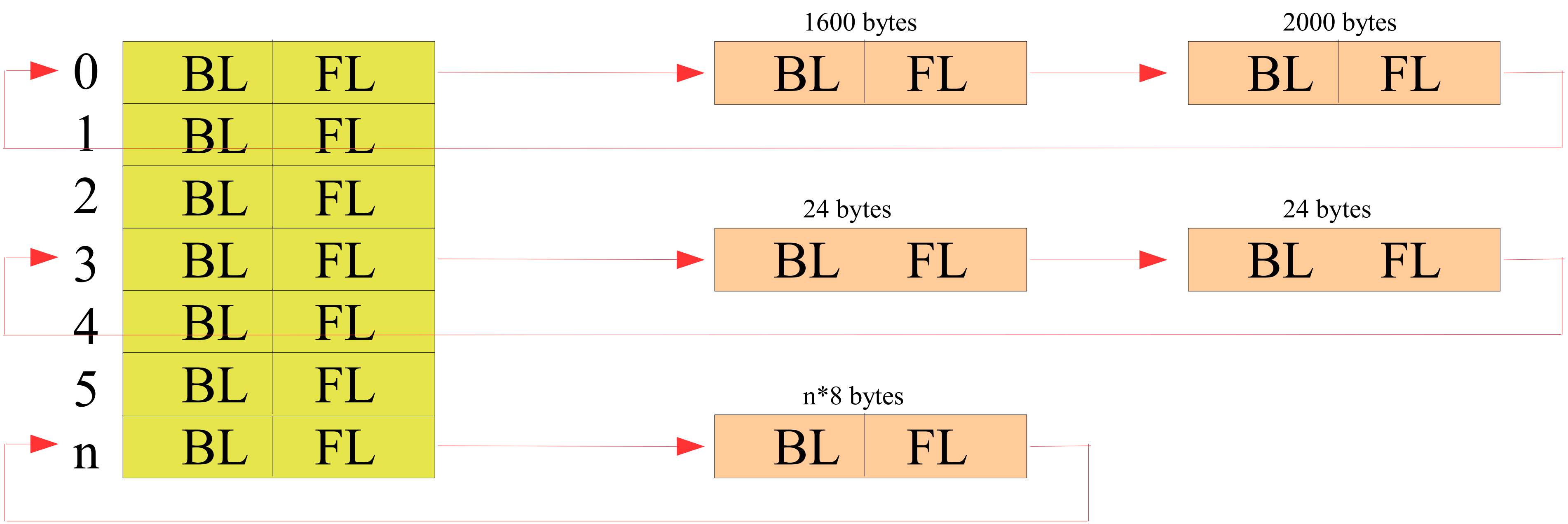
A quick look at the lookaside

- Lookaside



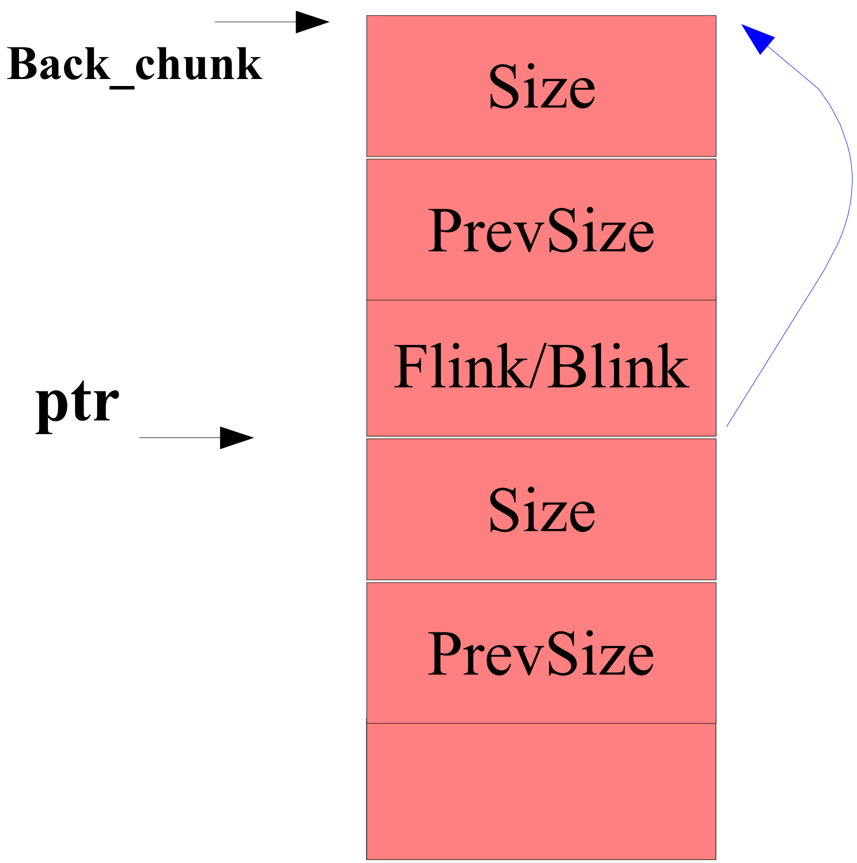
A quick look at the FreeList data structure

- FreeList



Where n < 128

Chunk coalescing: contiguous free chunks are joined to minimize fragmentation



PSize= *(ptr+2)
Back_chunk = ptr-(PSize*8)
if Back_chunk is not BUSY:
unlink(Back_chunk)

Chunks are split into two chunks when necessary

- Chunk splitting happens when a chunk of a specific size is requested and only larger chunks are available
- After a chunk is split, part of the chunk is returned to the process and part is inserted back into the FreeList

The life-cycle of a heap overflow

- There are four distinct segments in a heap exploit's life that you need to understand and control:
  - Before the overflow
  - Between the overflow and a Write4
  - Between the Write4 and the function pointer trigger
  - Hitting payload and onward (surviving)

} Might be the same

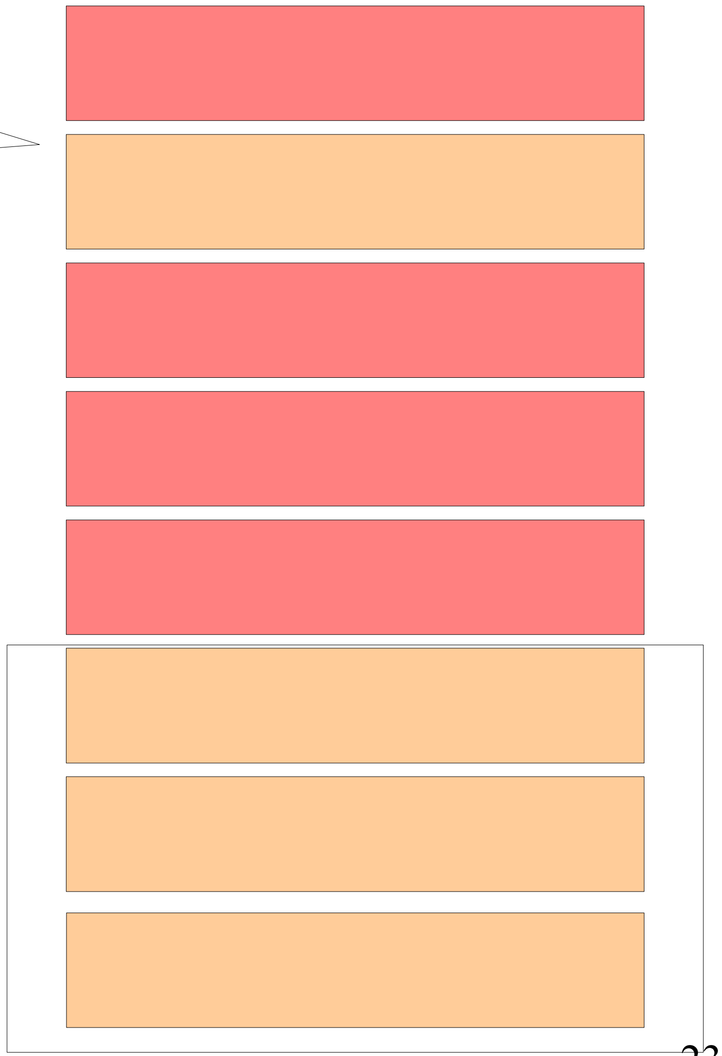
Heaps to not all start in the same configuration

- With heap overflows it is not always easy to control how an overwritten chunk will affect the operation of the heap algorithm
- Understanding how the allocation algorithm works, it becomes apparent that doing three allocations in a row does not mean it will return three bordering chunks
- Typically this problem is because of “Heap Holes”

Heap Holes

- Assume

Chunk is part of the FreeList[97]



Vulnerable(function)

```
A = Allocate(0x300);
B = Allocate(0x300);
Overwrite(A);
fn_ptr = B[4];
fn_ptr(“hello world”);
```

Heap Holes

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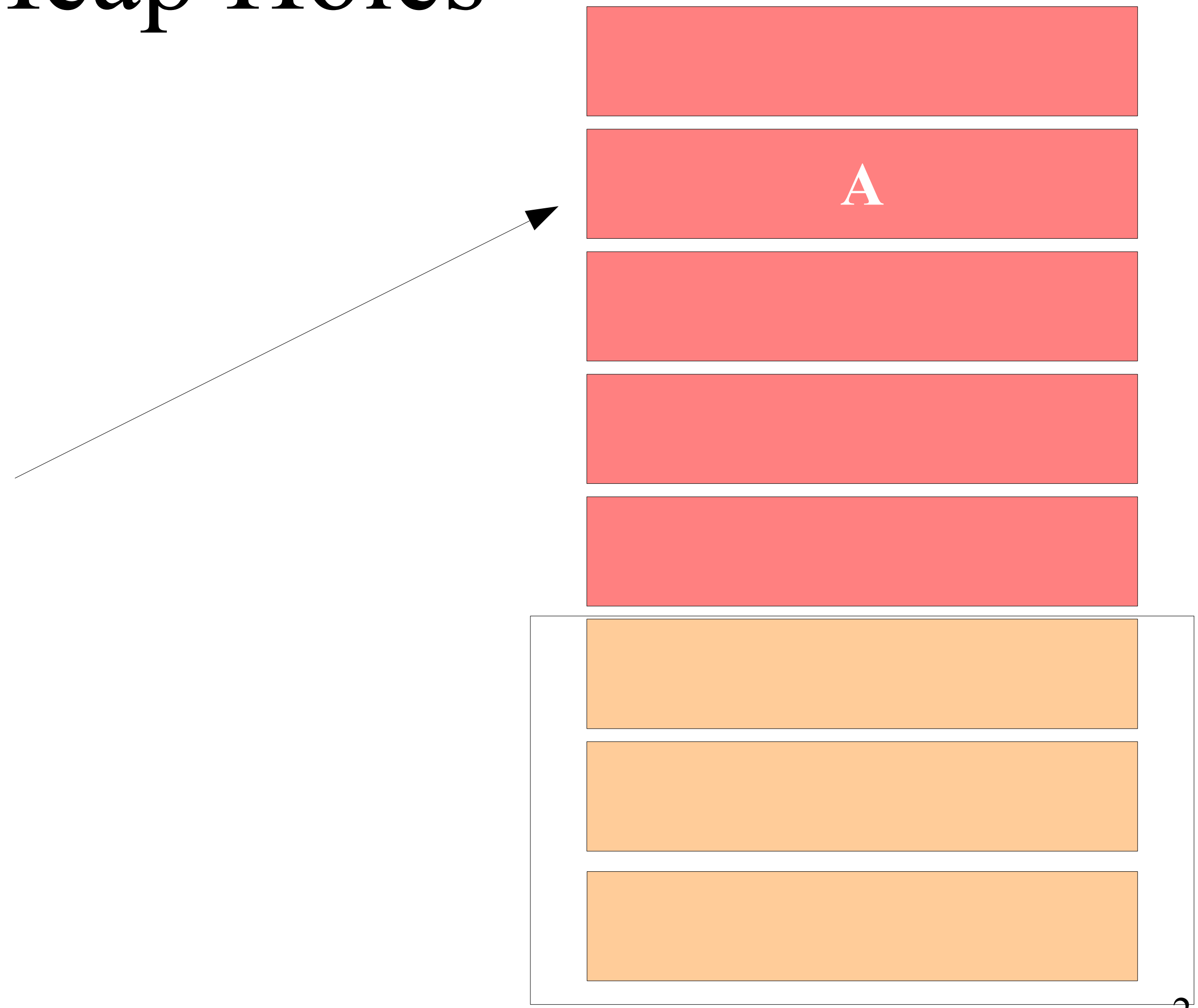

Heap Holes

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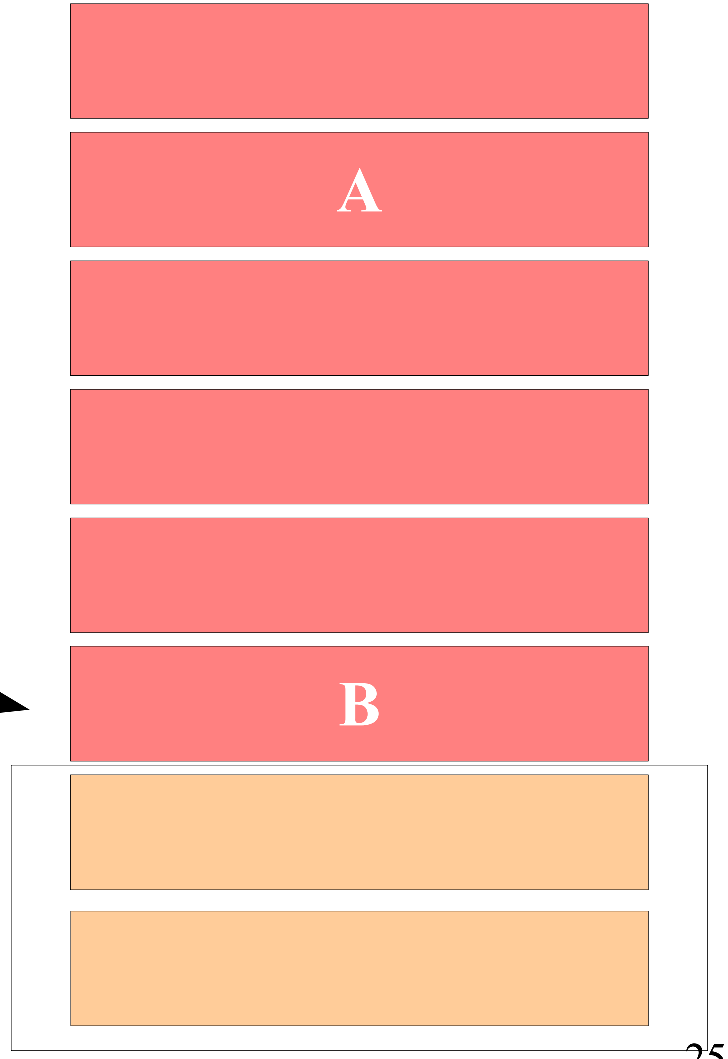

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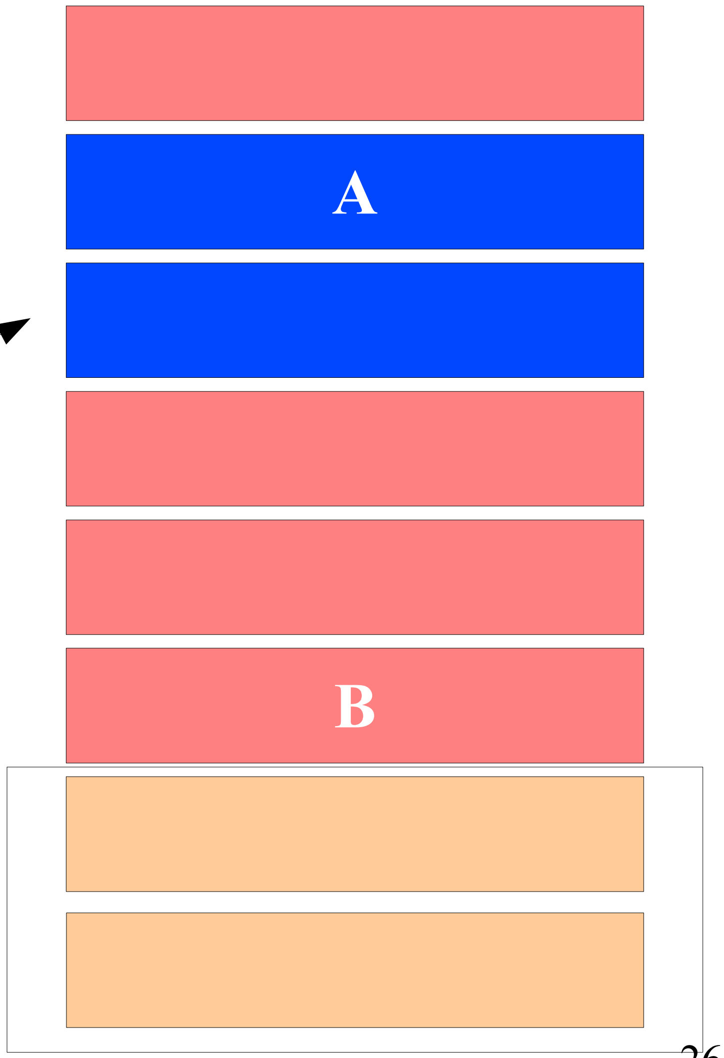

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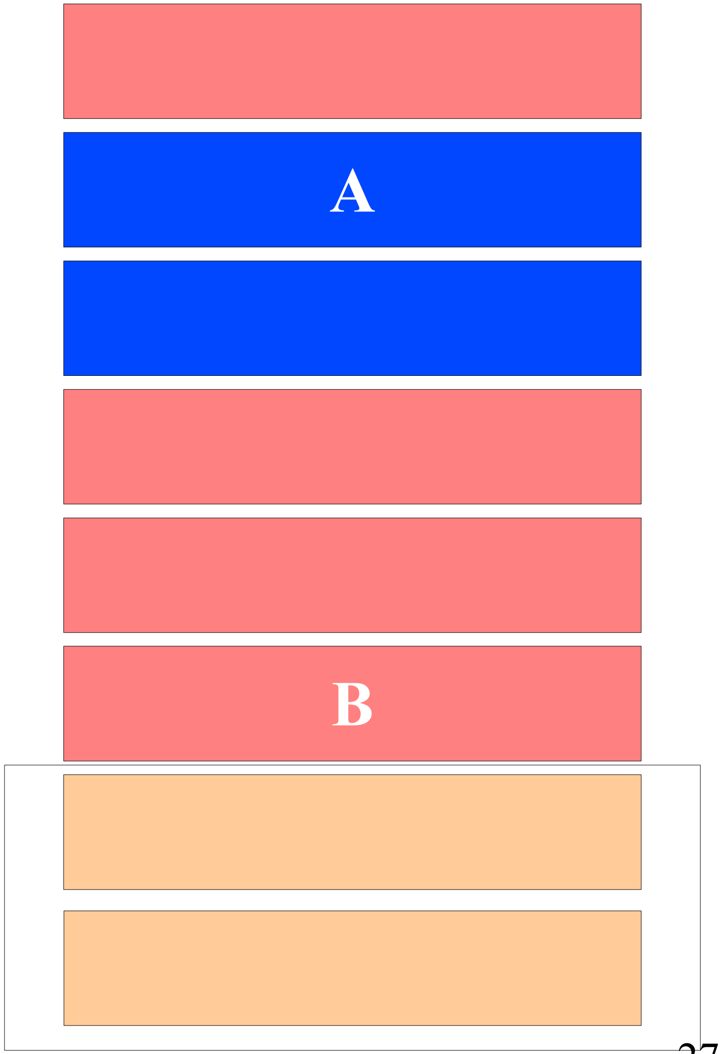


Two types of memory leaks are used in heap exploitation

- A memleak is a portion of memory that is **allocated** but **not deallocated** throughout the life of the target
- There are two types of memleaks:
  - Hard: Memleaks that remain allocated throughout the entire life of the target
  - Soft: Memleaks that remain allocated only for a set period of time (e.g. a memleak based on one connection)

Memleaks leak memory that is never freed back to the allocator

- Memory stays allocated and busy until the process/service is restarted
  - Obviously this is the kind of memory leak most programmers are trained to find and remove from their programs
- Several bad coding practises lead to hard memleaks
  - Sometimes can be found via static analysis

Hard Memleaks come from many places

- Allocations within a try-except block that forget to free in the except block
- Use of RaiseException() within a function before freeing locally bound allocations (RPC services do this a lot)
- Losing track of a pointer to the allocated chunk or overwriting the pointer. No sane reference is left behind for a free
- A certain code flow might return without freeing the locally bound allocation

Soft memory leaks are almost as useful to exploit writers

- Soft Memleaks are much easier to find:
  - Every connection to a server that is not disconnected, allocates memory
  - Variables that are set by a command and remain so until they are unset
  - Ex:

    X-LINK2STATE CHUNK=A allocates 0x400 bytes.

    X-LINK2STATE LAST CHUNK=A free that chunk.

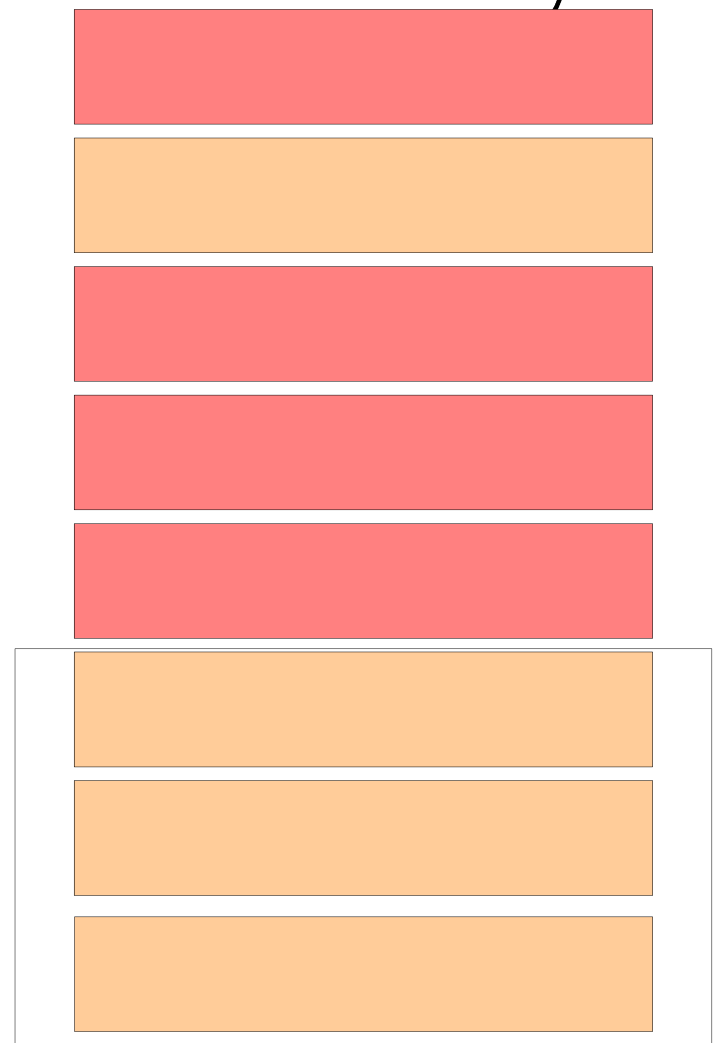
We correct our heap layout with memory leaks

- In summary, memleaks will help us do different things:
  - Filling the Lookaside
  - Filling the FreeList
  - Leaving Holes for a specific purpose

} Both have the same objective: to allow us to have consecutive chunks

Heap Rule #1: Force and control the layout

- Assume again



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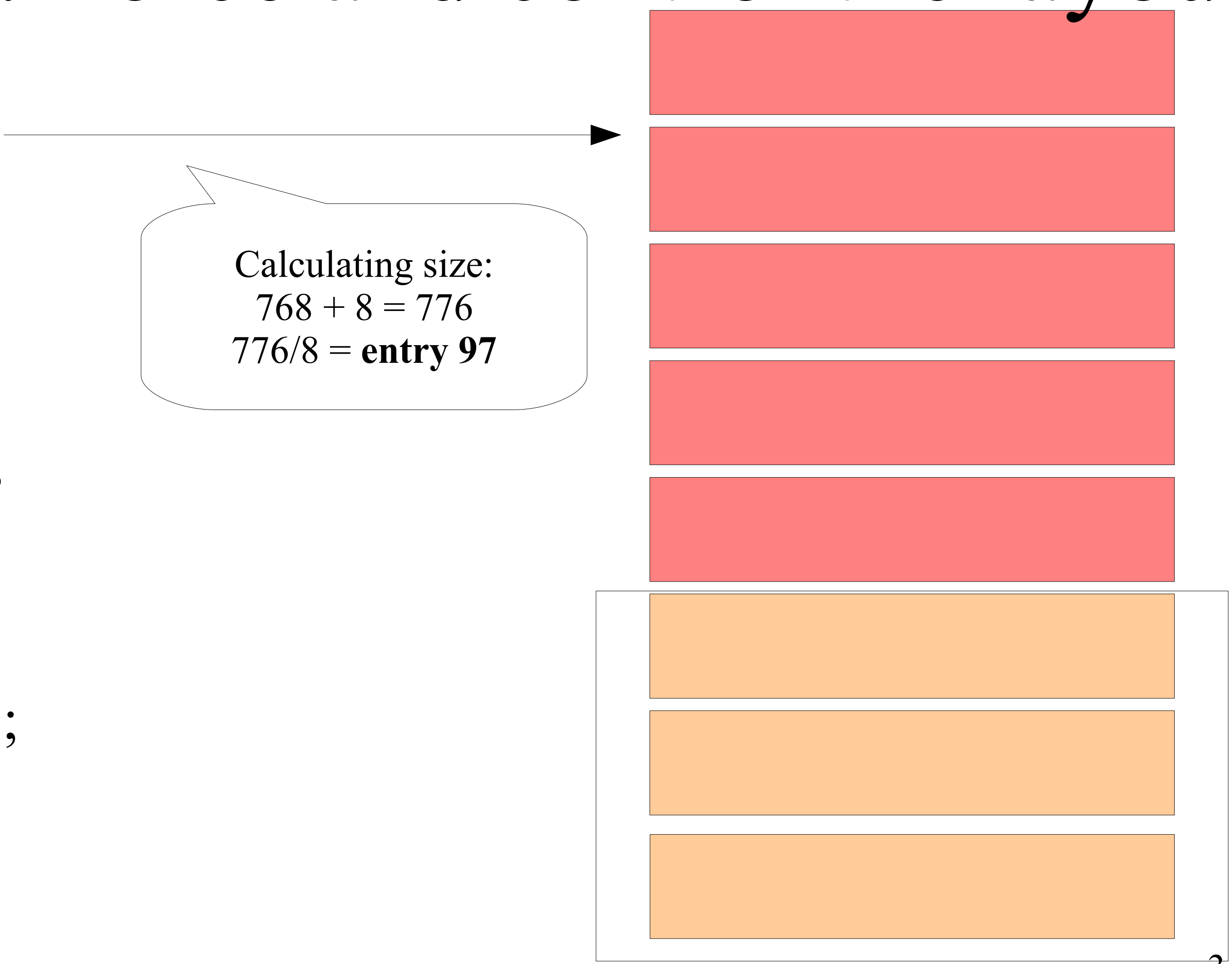
Heap Rule #1: Force and control the layout

- memleak(768)



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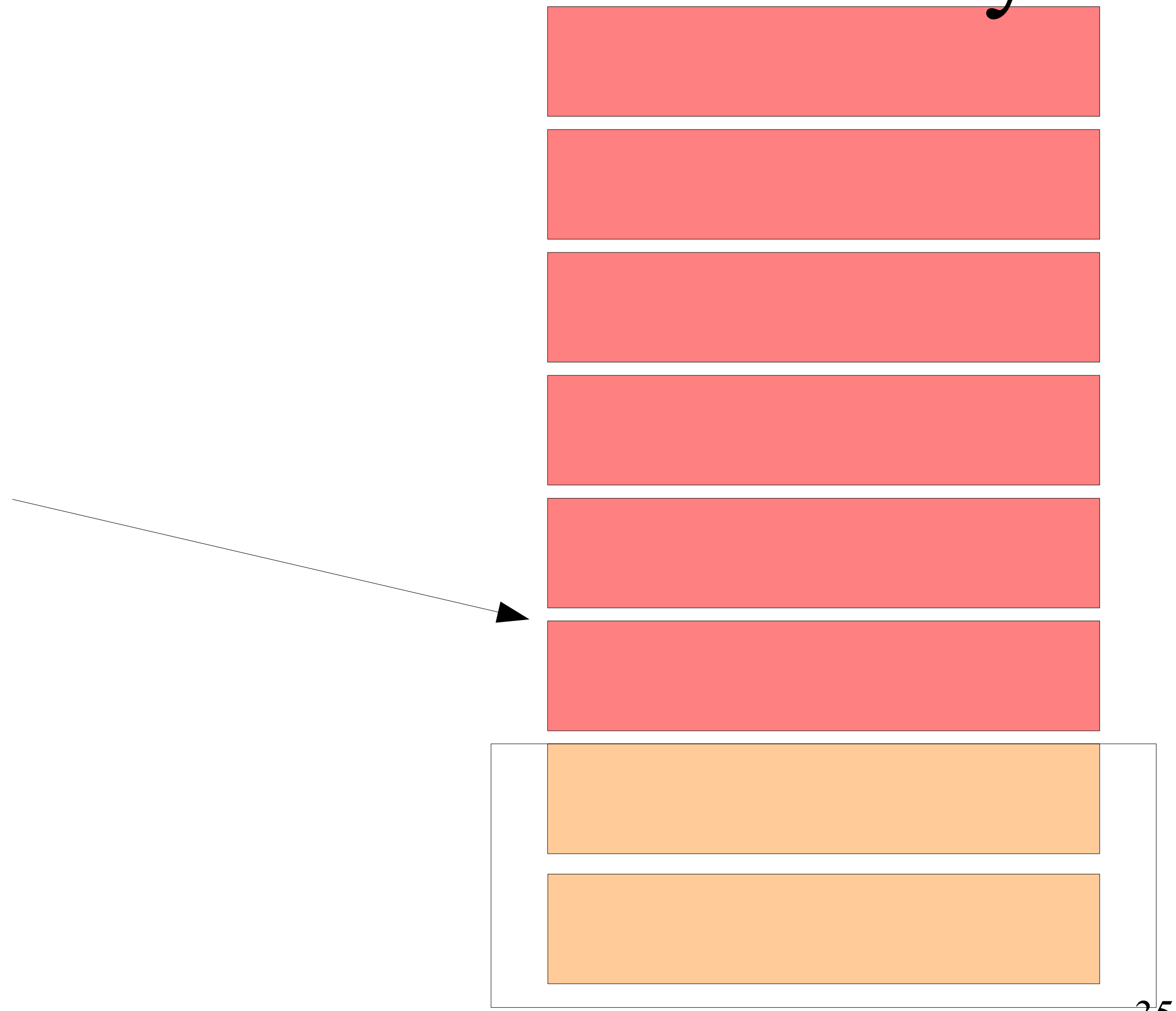

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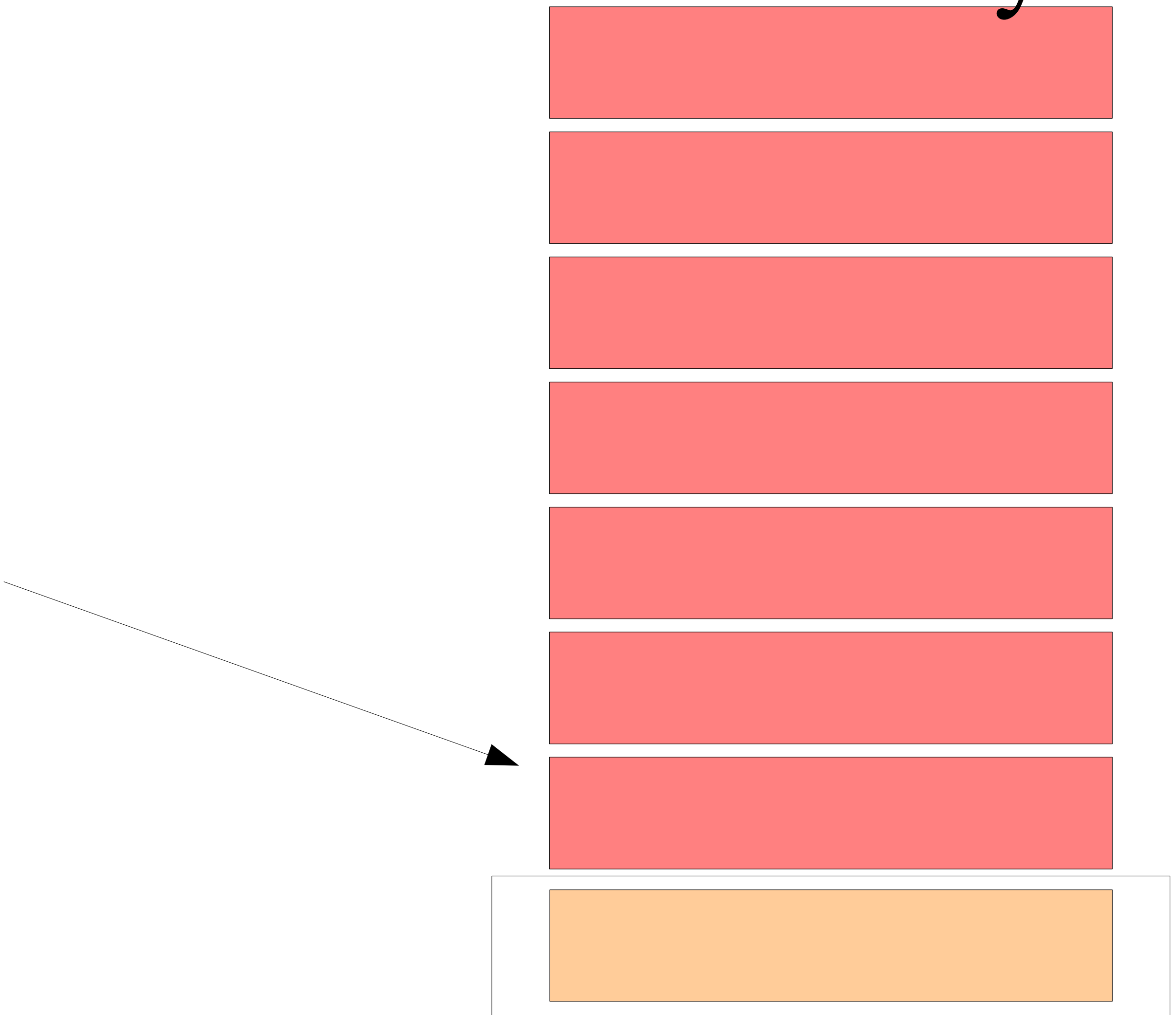

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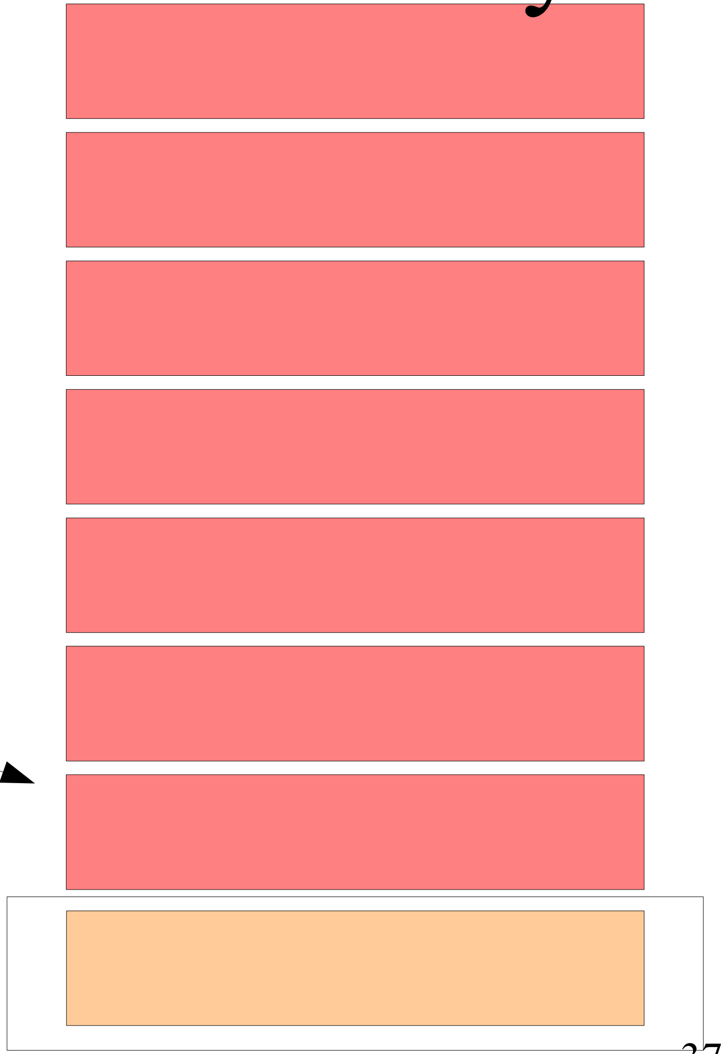

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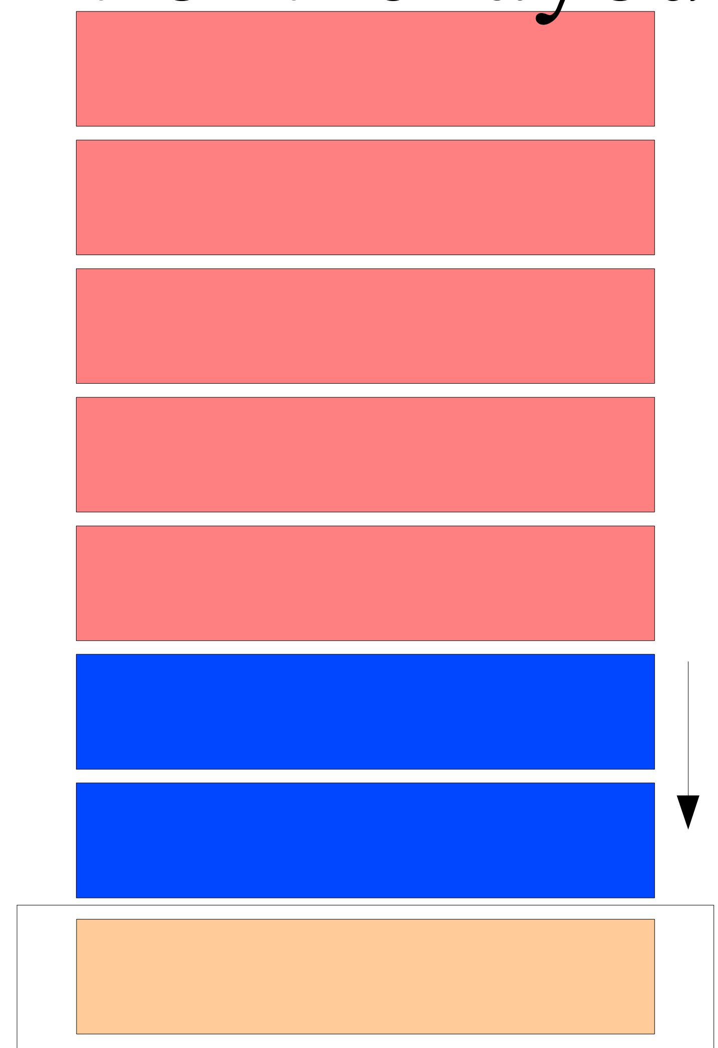

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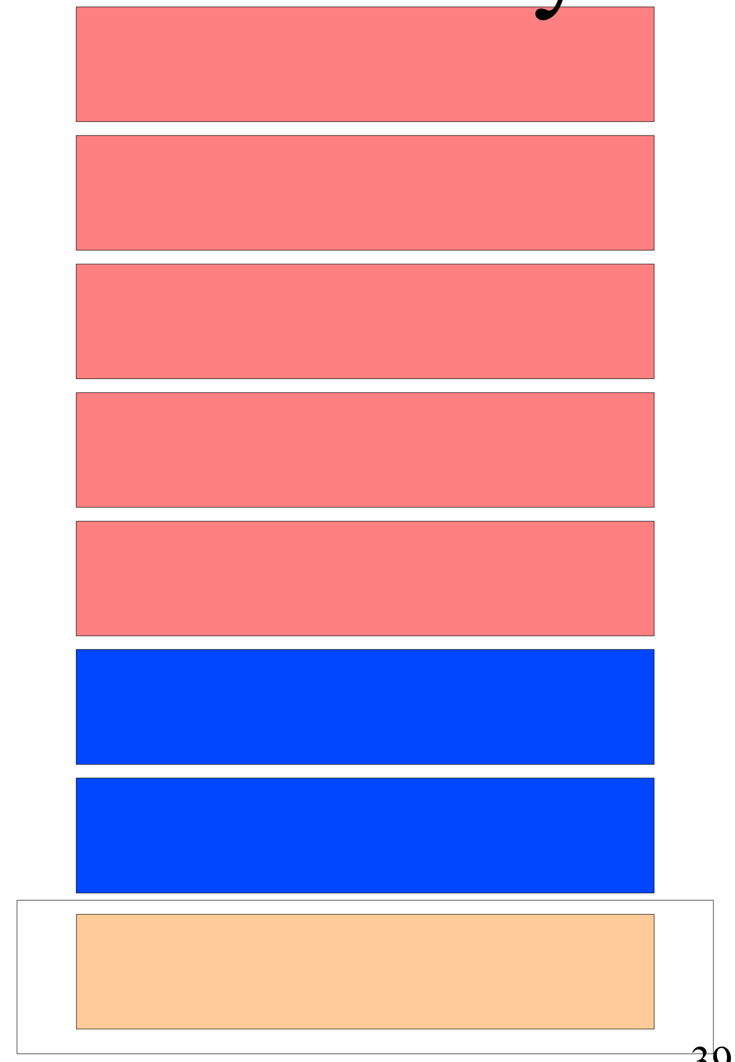

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Good exploits are the result of Intelligent Debugging

- With the new requirements for maximum deterministic control over the algorithm, exploiting the Win32 heap relies on intelligent debugging
- The need for a debugger that will fill these requirements arises

Immunity Debugger is the first debugger specifically for vulnerability development

- Powerful GUI
- WinDBG compatible commandline
- Powerful Python based scripting engine

Immunity Debugger's specialized heap analysis tools

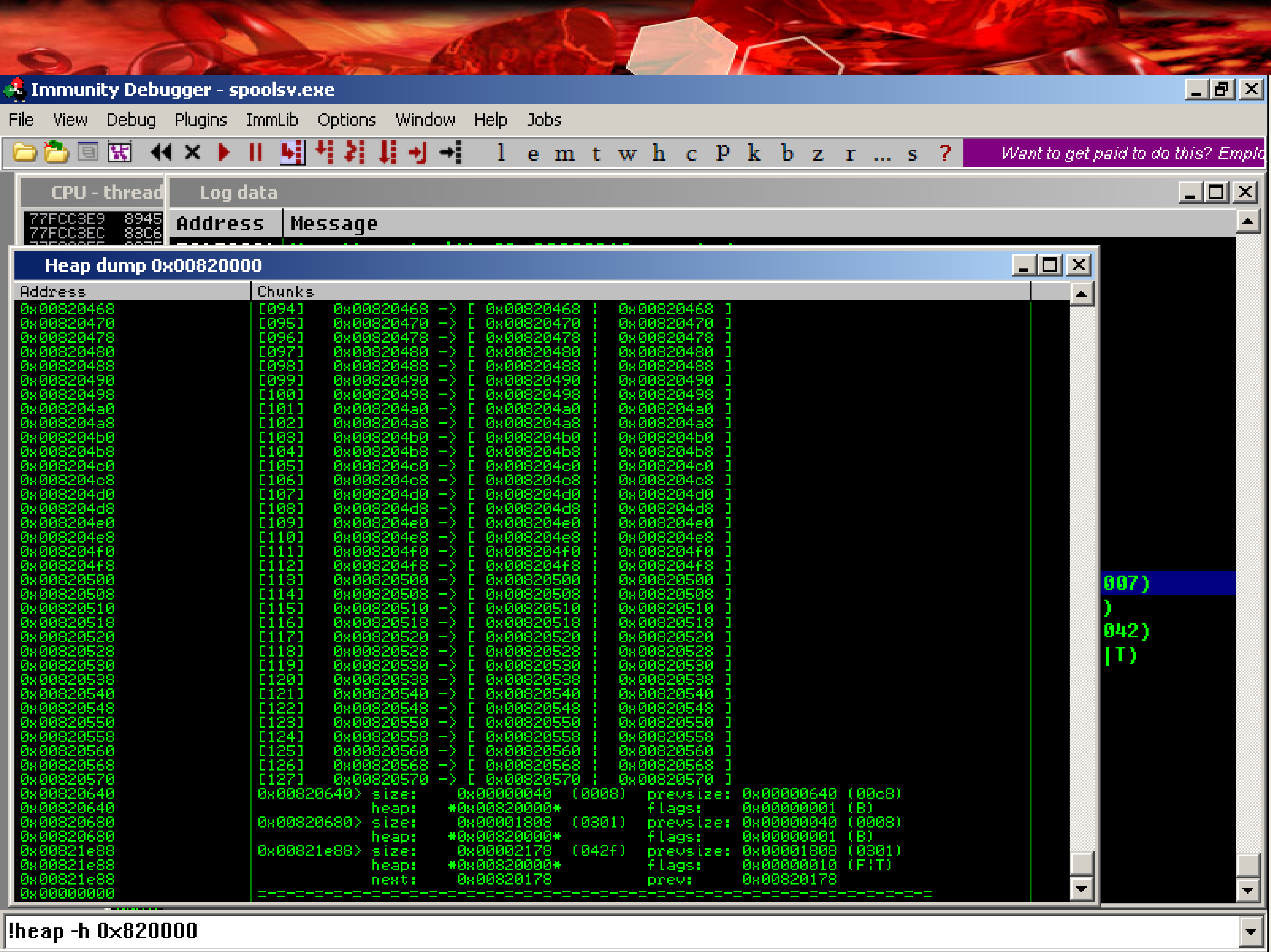
- A series of scripts offering everything needed for modern Win32 Heap exploitation

!heap	!searchheap
!funsniff	!heap_analize_chunk
!hippie	!modptr

Immunity Debugger

- Dumping the Heap:
  - !heap -h ADDRESS
- Scripting example:

```
pheap = imm.getHeap( heap )
for chunk in pheap.chunks:
  chunk.printchunk()
```



Immunity Debugger - spoolsv.exe
File View Debug Plugins ImmLib Options Window Help Jobs
l e m t w h c P k b z r ... s ?
Want to get paid to do this? Emplo
CPU - thread
77FCC3E9 8945
77FCC3EC 83C6
Log data
Address Message
Heap dump 0x00820000
Address Chunks
0x00820468 [094] 0x00820468 -> [0x00820468 | 0x00820468]
0x00820470 [095] 0x00820470 -> [0x00820470 | 0x00820470]
0x00820478 [096] 0x00820478 -> [0x00820478 | 0x00820478]
0x00820480 [097] 0x00820480 -> [0x00820480 | 0x00820480]
0x00820488 [098] 0x00820488 -> [0x00820488 | 0x00820488]
0x00820490 [099] 0x00820490 -> [0x00820490 | 0x00820490]
0x00820498 [100] 0x00820498 -> [0x00820498 | 0x00820498]
0x008204a0 [101] 0x008204a0 -> [0x008204a0 | 0x008204a0]
0x008204a8 [102] 0x008204a8 -> [0x008204a8 | 0x008204a8]
0x008204b0 [103] 0x008204b0 -> [0x008204b0 | 0x008204b0]
0x008204b8 [104] 0x008204b8 -> [0x008204b8 | 0x008204b8]
0x008204c0 [105] 0x008204c0 -> [0x008204c0 | 0x008204c0]
0x008204c8 [106] 0x008204c8 -> [0x008204c8 | 0x008204c8]
0x008204d0 [107] 0x008204d0 -> [0x008204d0 | 0x008204d0]
0x008204d8 [108] 0x008204d8 -> [0x008204d8 | 0x008204d8]
0x008204e0 [109] 0x008204e0 -> [0x008204e0 | 0x008204e0]
0x008204e8 [110] 0x008204e8 -> [0x008204e8 | 0x008204e8]
0x008204f0 [111] 0x008204f0 -> [0x008204f0 | 0x008204f0]
0x008204f8 [112] 0x008204f8 -> [0x008204f8 | 0x008204f8]
0x00820500 [113] 0x00820500 -> [0x00820500 | 0x00820500]
0x00820508 [114] 0x00820508 -> [0x00820508 | 0x00820508]
0x00820510 [115] 0x00820510 -> [0x00820510 | 0x00820510]
0x00820518 [116] 0x00820518 -> [0x00820518 | 0x00820518]
0x00820520 [117] 0x00820520 -> [0x00820520 | 0x00820520]
0x00820528 [118] 0x00820528 -> [0x00820528 | 0x00820528]
0x00820530 [119] 0x00820530 -> [0x00820530 | 0x00820530]
0x00820538 [120] 0x00820538 -> [0x00820538 | 0x00820538]
0x00820540 [121] 0x00820540 -> [0x00820540 | 0x00820540]
0x00820548 [122] 0x00820548 -> [0x00820548 | 0x00820548]
0x00820550 [123] 0x00820550 -> [0x00820550 | 0x00820550]
0x00820558 [124] 0x00820558 -> [0x00820558 | 0x00820558]
0x00820560 [125] 0x00820560 -> [0x00820560 | 0x00820560]
0x00820568 [126] 0x00820568 -> [0x00820568 | 0x00820568]
0x00820570 [127] 0x00820570 -> [0x00820570 | 0x00820570]
0x00820640 0x00820640> size: 0x00000040 (0008) prevsize: 0x00000640 (00c8)
0x00820640 heap: *0x00820000* flags: 0x00000001 (B)
0x00820680 0x00820680> size: 0x00001808 (0301) prevsize: 0x00000040 (0008)
0x00820680 heap: *0x00820000* flags: 0x00000001 (B)
0x00821e88 0x00821e88> size: 0x00002178 (042f) prevsize: 0x00001808 (0301)
0x00821e88 heap: *0x00820000* flags: 0x00000010 (F|T)
0x00821e88 next: 0x00820178 prev: 0x00820178
0x00000000 -=
007)
)
042)
|T)
!heap -h 0x820000

Searching the heap using Immlib

- Search the heap
  - !searchheap

```
what    (size,usize,psize,upsize,flags,address,
         next,prev)

action  (=,>,<,>=,<=,&,not,!=)

value   (value to search for)

heap    (optional: filter the search by heap)
```

- Scripting example:

```
SearchHeap(imm, what, action, value, heap = heap)
```

Comparing a heap before and after you break it

- Dumping a Broken Heap:
  - Save state:
    - !heap -h ADDRESS -s
  - Restore State:
    - !heap -h ADDRESS -r

Heap Fingerprinting

- To craft a correct Heap layout we need a proper understanding of the allocation pattern of different functions in the target process
- This means there is a need for fingerprinting the heap flow of a specific function

Heap Fingerprinting

- !funsniff <address>
  - fingerprint the allocation pattern of the given function
  - find memleaks
  - double free
  - memory freed of a chunk not belonging to our current heap flow (Important for soft memleaks)

Function Sniffing

Address	Data
0x77d4178c	Free (0x00070000, 0x00000000, 0x000a2808)
0x77d4178c	Free (0x00070000, 0x00000000, 0x000a6a30)
0x77d4178c	Free (0x00070000, 0x00000000, 0x000bf758)
0x77f8f134	Free (0x00070000, 0x00000000, 0x000a6950)
0x77d3c2f7	Free (0x00070000, 0x00000000, 0x0008d010)
0x77d3c2f7	Free (0x00070000, 0x00000000, 0x00000000)
0x77f8f134	Free (0x00070000, 0x00000000, 0x000a6978)
0x77d3c2f7	Free (0x00070000, 0x00000000, 0x00000000)
0x7cdce412	Free (0x00070000, 0x00000000, 0x0008ec50)
0x76a94663	Free (0x00c50000, 0x00000000, 0x00c56fe8)
0x78001532	Alloc(0x00230000, 0x00000000, 0x00000080) -> 0x002373b8
0x77f8e6b9	Alloc(0x00070000, 0x00000000, 0x00000020) -> 0x000a6978
0x77f8e6b9	Alloc(0x00070000, 0x00000000, 0x00000020) -> 0x000a6950
0x7c58dc67	Alloc(0x00070000, 0x00100008, 0x0000001c) -> 0x000a6a30
0x76b01909	Free (0x00070000, 0x00000000, 0x000a6a30)
0x76b01c06	Free (0x00070000, 0x00000000, 0x00000000)
0x76b01c0b	Free (0x00070000, 0x00000000, 0x00000000)
0x76b01c10	Free (0x00070000, 0x00000000, 0x00000000)
0x76b01c15	Free (0x00070000, 0x00000000, 0x00000000)
0x76b01c1a	Free (0x00070000, 0x00000000, 0x00000000)
0x77f8f134	Free (0x00070000, 0x00000000, 0x000a6950)
0x77f8f134	Free (0x00070000, 0x00000000, 0x000a6978)
0x76b01bea	Free (0x00230000, 0x00000000, 0x002373b8)
0x76a94620	Free (0x00c50000, 0x00000000, 0x00c55098)
0x76a94620	Free (0x00c50000, 0x00000000, 0x00c56fb0)
0x76a94620	Free (0x00c50000, 0x00000000, 0x00c56d90)
0x00000000	Chunk freed but not allocated on this heap flow
0x76b01c1a	Free (0x00070000, 0x00000000, 0x00000000)
0x00000000	Memleak detected
0x78001532	Alloc(0x00230000, 0x00000000, 0x00000110) -> 0x00237440
0x00237438	0x00237438> size: 0x00000118 (0023) prevsize: 0x00000088 (0011)
0x00237438	heap: *0x00000000* flags: 0x00000001 (B)
0x00237440	> String: ',NoCacheCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC

Automated data type discovery using Immlib

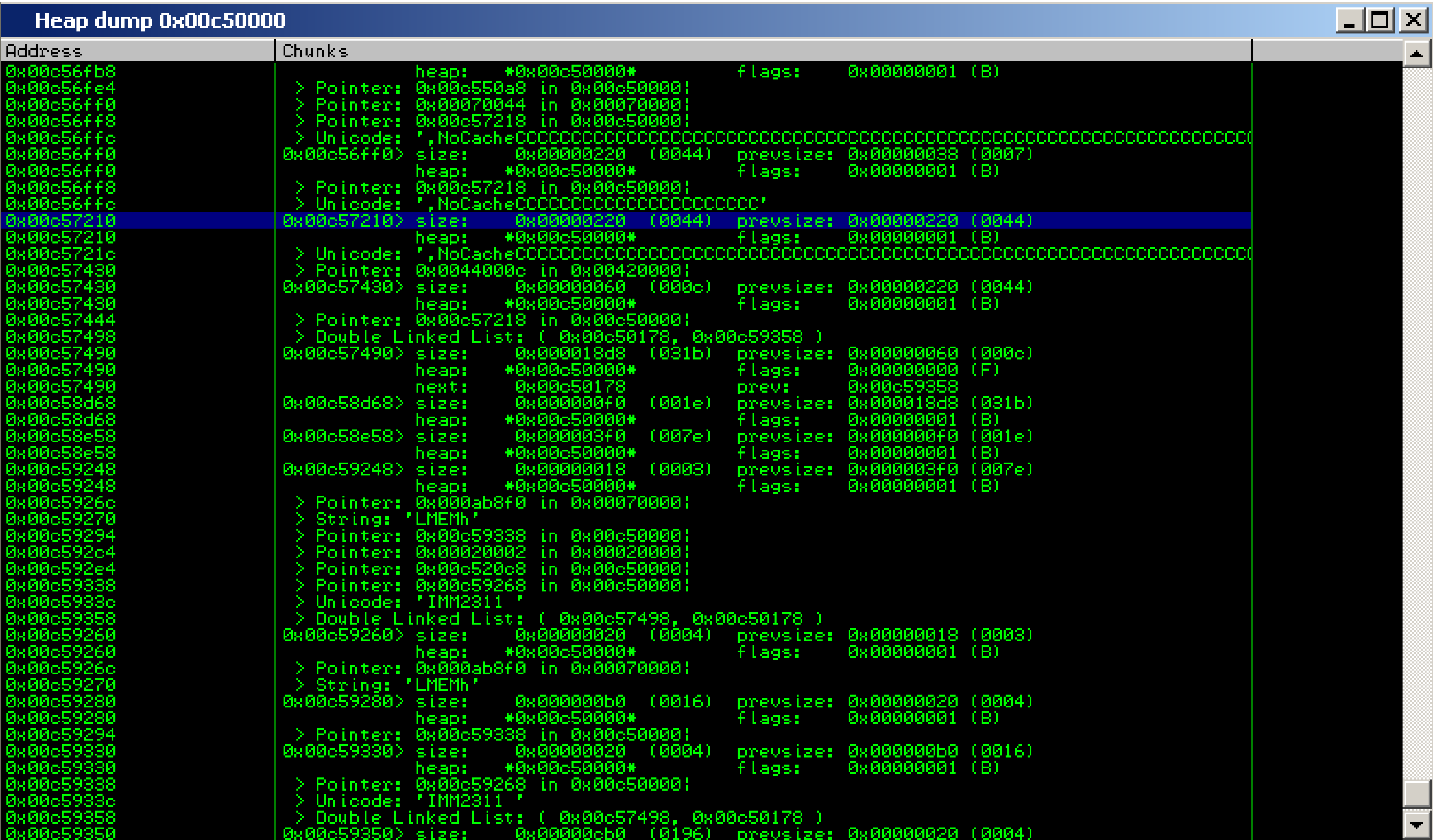
- As we now know overwriting the metadata of chunks to get a Write4 primitive is mostly no longer viable
- The next step of heap exploitation is taking advantage of the **content of chunks**
- We need straightforward runtime recognition of chunk content

Immunity Debugger offers simple runtime analysis of heap data to find data types

- String/Unicode
- Pointers (Function Pointer, Data pointer, Stack Pointer)
- Double Linked lists
  - Important because they have their own unlink() write4 primitives!

Data Discovery

- !heap -h HEAP_ADDRESS -d
  - See next slide for awesome screenshot of this in action!



Heap dump 0x00c50000

```
Address     Chunks
0x00c56fb8              heap:    *0x00c50000*           flags:     0x00000001 (B)
0x00c56fe4   > Pointer: 0x00c550a8  in 0x00c50000!
0x00c56ff0   > Pointer: 0x00070044  in 0x00070000!
0x00c56ff8   > Pointer: 0x00c57218  in 0x00c50000!
0x00c56ffc   > Unicode: ',NoCacheCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC
0x00c56ff0  0x00c56ff0> size:     0x00000220  (0044)  prevsize: 0x00000038 (0007)
0x00c56ff0              heap:    *0x00c50000*           flags:     0x00000001 (B)
0x00c56ff8   > Pointer: 0x00c57218  in 0x00c50000!
0x00c56ffc   > Unicode: ',NoCacheCCCCCCCCCCCCCCCCCCCCCC'
0x00c57210  0x00c57210> size:     0x00000220  (0044)  prevsize: 0x00000220 (0044)
0x00c57210              heap:    *0x00c50000*           flags:     0x00000001 (B)
0x00c5721c   > Unicode: ',NoCacheCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC
0x00c57430   > Pointer: 0x0044000c  in 0x00420000!
0x00c57430  0x00c57430> size:     0x00000060  (000c)  prevsize: 0x00000220 (0044)
0x00c57430              heap:    *0x00c50000*           flags:     0x00000001 (B)
0x00c57444   > Pointer: 0x00c57218  in 0x00c50000!
0x00c57498   > Double Linked List: ( 0x00c50178, 0x00c59358 )
0x00c57490  0x00c57490> size:     0x000018d8  (031b)  prevsize: 0x00000060 (000c)
0x00c57490              heap:    *0x00c50000*           flags:     0x00000000 (F)
0x00c57490              next:     0x00c50178            prev:      0x00c59358
0x00c58d68  0x00c58d68> size:     0x000000f0  (001e)  prevsize: 0x000018d8 (031b)
0x00c58d68              heap:    *0x00c50000*           flags:     0x00000001 (B)
0x00c58e58  0x00c58e58> size:     0x000003f0  (007e)  prevsize: 0x000000f0 (001e)
0x00c58e58              heap:    *0x00c50000*           flags:     0x00000001 (B)
0x00c59248  0x00c59248> size:     0x00000018  (0003)  prevsize: 0x000003f0 (007e)
0x00c59248              heap:    *0x00c50000*           flags:     0x00000001 (B)
0x00c5926c   > Pointer: 0x000ab8f0  in 0x00070000!
0x00c59270   > String: 'LMEMh'
0x00c59294   > Pointer: 0x00c59338  in 0x00c50000!
0x00c592c4   > Pointer: 0x00020002  in 0x00020000!
0x00c592e4   > Pointer: 0x00c520c8  in 0x00c50000!
0x00c59338   > Pointer: 0x00c59268  in 0x00c50000!
0x00c5933c   > Unicode: 'IMM2311 '
0x00c59358   > Double Linked List: ( 0x00c57498, 0x00c50178 )
0x00c59260  0x00c59260> size:     0x00000020  (0004)  prevsize: 0x00000018 (0003)
0x00c59260              heap:    *0x00c50000*           flags:     0x00000001 (B)
0x00c5926c   > Pointer: 0x000ab8f0  in 0x00070000!
0x00c59270   > String: 'LMEMh'
0x00c59280  0x00c59280> size:     0x000000b0  (0016)  prevsize: 0x00000020 (0004)
0x00c59280              heap:    *0x00c50000*           flags:     0x00000001 (B)
0x00c59294   > Pointer: 0x00c59338  in 0x00c50000!
0x00c59330  0x00c59330> size:     0x00000020  (0004)  prevsize: 0x000000b0 (0016)
0x00c59330              heap:    *0x00c50000*           flags:     0x00000001 (B)
0x00c59338   > Pointer: 0x00c59268  in 0x00c50000!
0x00c5933c   > Unicode: 'IMM2311 '
0x00c59358   > Double Linked List: ( 0x00c57498, 0x00c50178 )
0x00c59350  0x00c59350> size:     0x00000cb0  (0196)  prevsize: 0x00000020 (0004)
```

KNOWING YOU'RE SECURE

Data Discovery can be scripted easily

```
import libdatatype

dt  = libdatatype.DataTypes( imm )

ret = dt.Discover( memory, address, what)
```

memory memory to inspect

address address of the inspected memory

what (all, pointers, strings, asciistrings, unicodestrings, doublelinkedlists, exploitable)

```
for obj in ret:

    print ret.Print()
```

Heap Fuzzing heaps you discover a way to obtain the correct layout

- Sometimes controlling the layout is not as easy as you think, even though it sounds straightforward in theory
- From this the concept of Fuzzing the Heap arises, to help in discovering the correct layout for your process (manually or automatically)

Heap Fuzzing

- !chunkanalizehook
- Get the status of a given chunk at a specific moment. Answers the common questions:
  - What chunks are bordering your chunk?
  - What is the data in those chunks?

Heap Fuzzing

- *Run the script, Fuzz and get result...*
- usage:

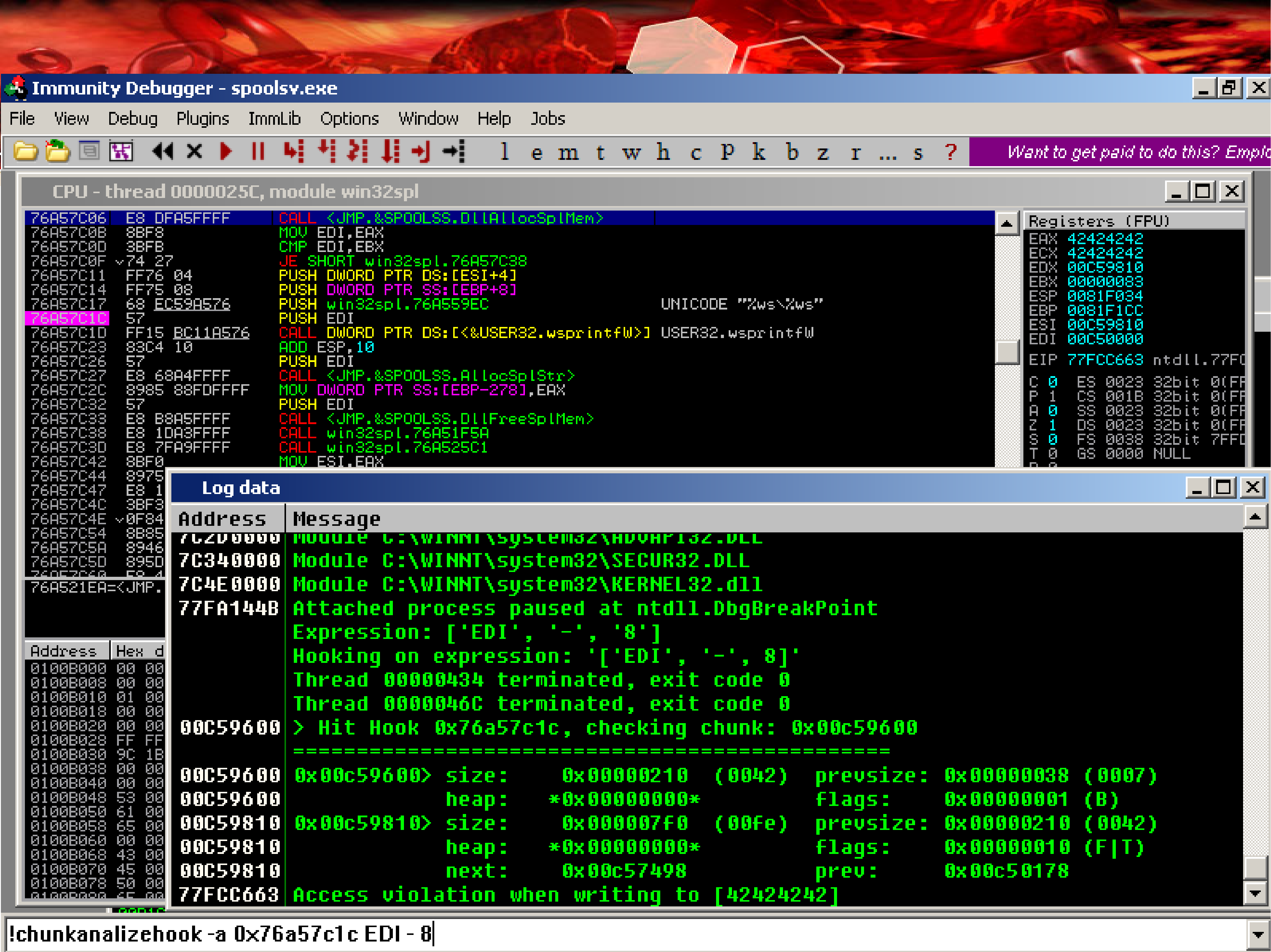
  !chunkanalizehook (-d) -a ADDRES <exp>

  -a ADDRESS   address of the hook

  -d   find datatypes

  <exp>   how to find the chunk

ex: *!chunkanalizehook -d -a 0x77fcb703 EBX - 8*



Immunity Debugger - spoolsv.exe
File View Debug Plugins ImmLib Options Window Help Jobs
Want to get paid to do this? Emplo
CPU - thread 0000025C, module win32spl
76A57C06 E8 DFA5FFFF CALL <JMP.&SPOOLSS.DllAllocSplMem>
76A57C0B 8BF8 MOV EDI,EAX
76A57C0D 3BFB CMP EDI,EBX
76A57C0F 74 27 JE SHORT win32spl.76A57C38
76A57C11 FF76 04 PUSH DWORD PTR DS:[ESI+4]
76A57C14 FF75 08 PUSH DWORD PTR SS:[EBP+8]
76A57C17 68 EC59A576 PUSH win32spl.76A559EC UNICODE "%ws\%ws"
76A57C1C 57 PUSH EDI
76A57C1D FF15 BC11A576 CALL DWORD PTR DS:[<&USER32.wsprintfW>] USER32.wsprintfW
76A57C23 83C4 10 ADD ESP,10
76A57C26 57 PUSH EDI
76A57C27 E8 68A4FFFF CALL <JMP.&SPOOLSS.AllocSplStr>
76A57C2C 8985 88FDFFFF MOV DWORD PTR SS:[EBP-278],EAX
76A57C32 57 PUSH EDI
76A57C33 E8 B8A5FFFF CALL <JMP.&SPOOLSS.DllFreeSplMem>
76A57C38 E8 1DA3FFFF CALL win32spl.76A51F5A
76A57C3D E8 7FA9FFFF CALL win32spl.76A525C1
76A57C42 8BF0 MOV ESI,EAX
Registers (FPU)
EAX 42424242
ECX 42424242
EDX 00C59810
EBX 00000083
ESP 0081F034
EBP 0081F1CC
ESI 00C59810
EDI 00C50000
EIP 77FCC663 ntdll.77FC
Log data
Address Message
7C340000 Module C:\WINNT\system32\SECUR32.DLL
7C4E0000 Module C:\WINNT\system32\KERNEL32.dll
77FA144B Attached process paused at ntdll.DbgBreakPoint
Expression: ['EDI', '-', '8']
Hooking on expression: '['EDI', '-', 8]'
Thread 00000434 terminated, exit code 0
Thread 0000046C terminated, exit code 0
00C59600 > Hit Hook 0x76a57c1c, checking chunk: 0x00c59600
==
00C59600 0x00c59600> size: 0x00000210 (0042) prevsize: 0x00000038 (0007)
00C59600 heap: *0x00000000* flags: 0x00000001 (B)
00C59810 0x00c59810> size: 0x000007f0 (00fe) prevsize: 0x00000210 (0042)
00C59810 heap: *0x00000000* flags: 0x00000010 (F|T)
00C59810 next: 0x00c57498 prev: 0x00c50178
77FCC663 Access violation when writing to [42424242]
!chunkanalizehook -a 0x76a57c1c EDI - 8

Inject Hook

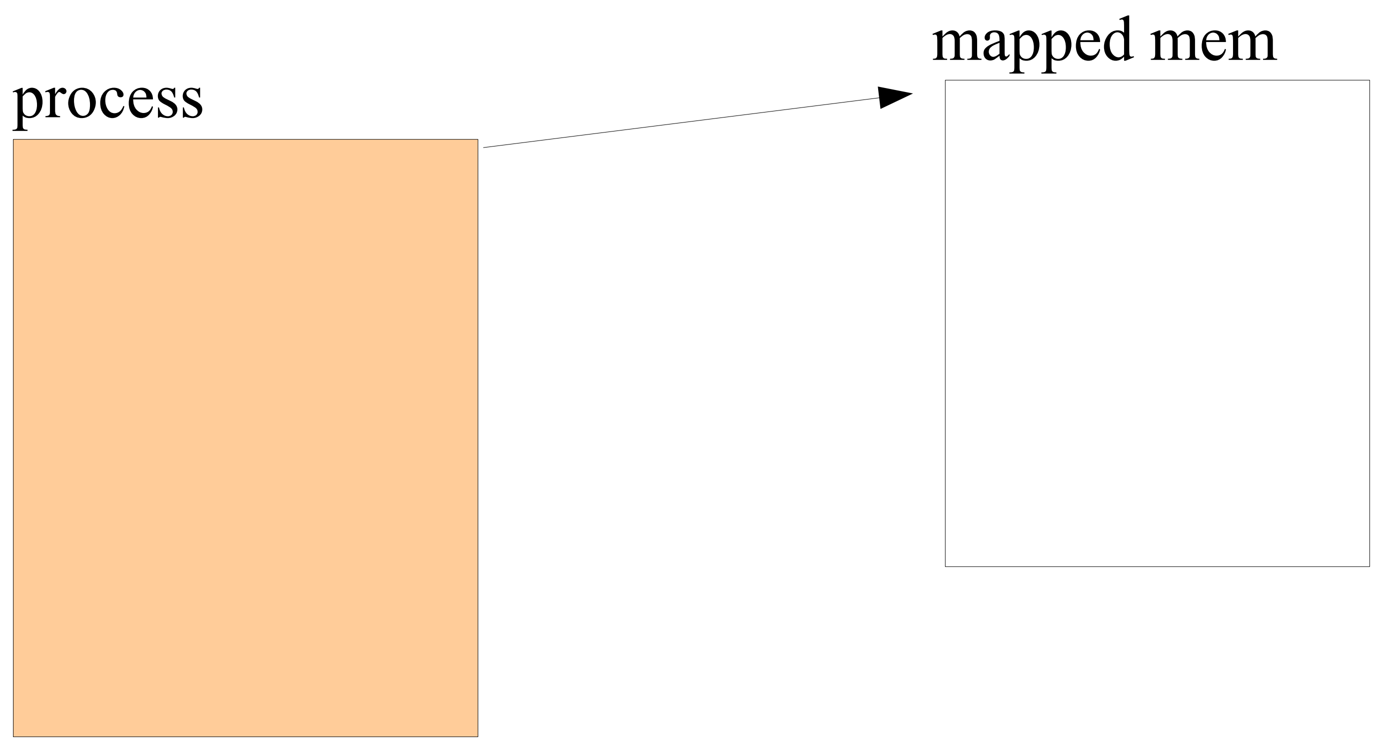
- One of the biggest problems when hooking an allocation function is speed
- Allocations are so frequent in some processes that a hook ends up slowing down the process and as a result changing the natural heap behaviour (thus changing the layout)
  - lsass
  - iexplorer

Inject Hooks into the target process speeds things up

- This means doing function redirection and logging the result in the debugger itself (Avoiding breakpoints, event handling, etc)
- Can be done automatically via Immlib

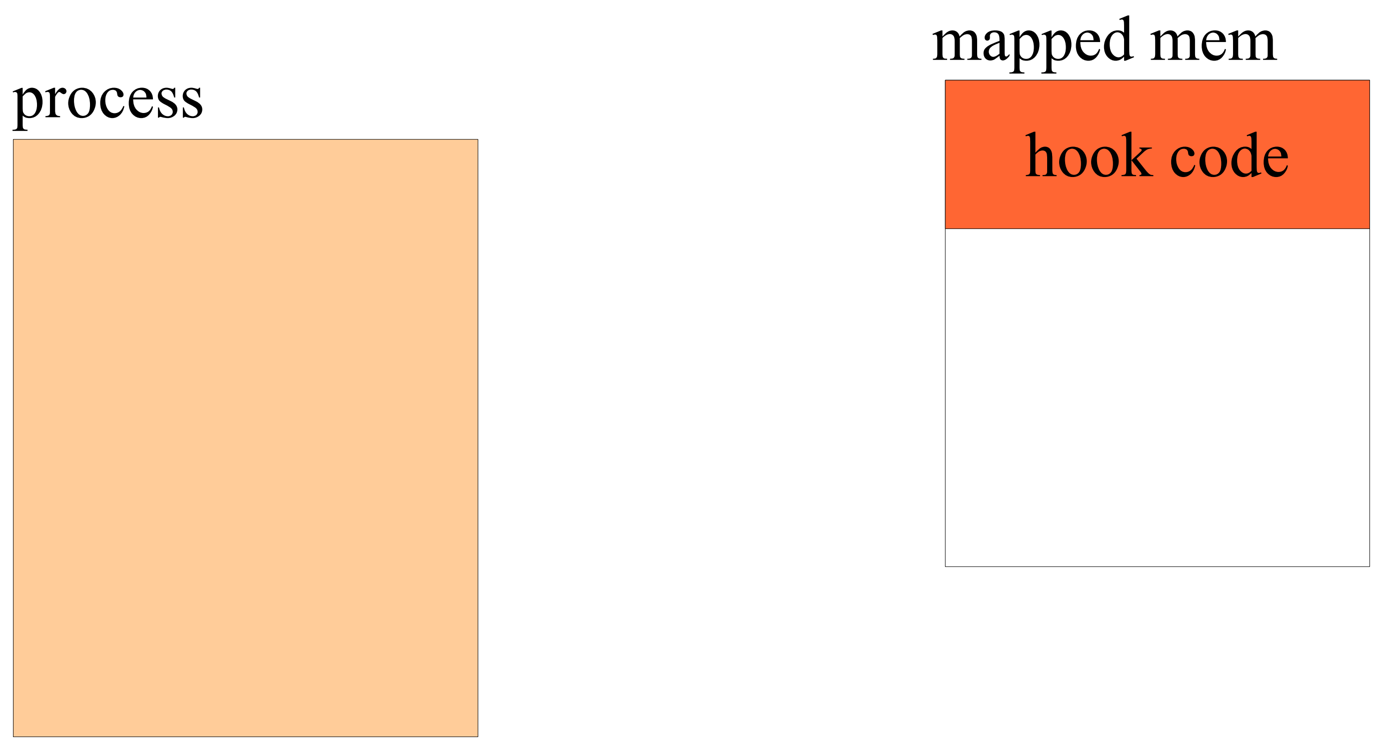
Inject Hook

VirtualAllocEx



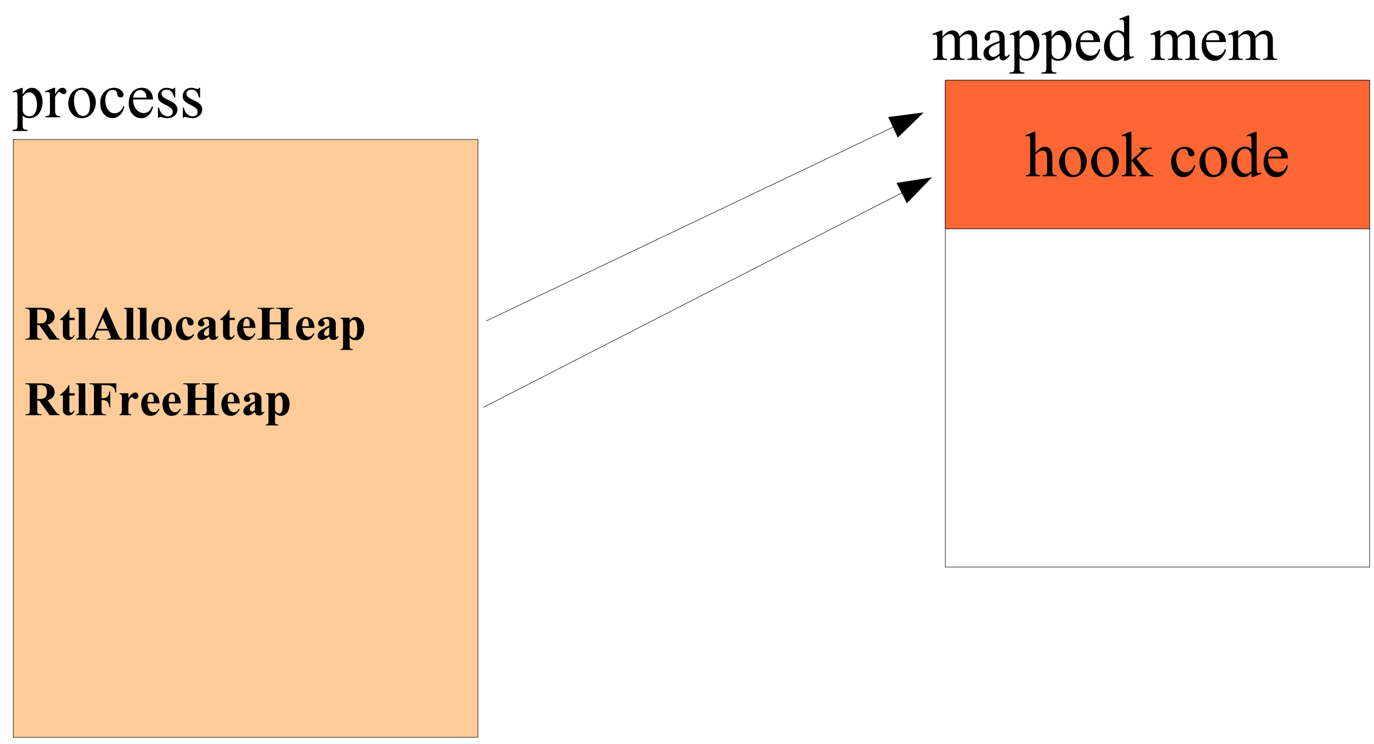
Inject Hook

InjectHooks



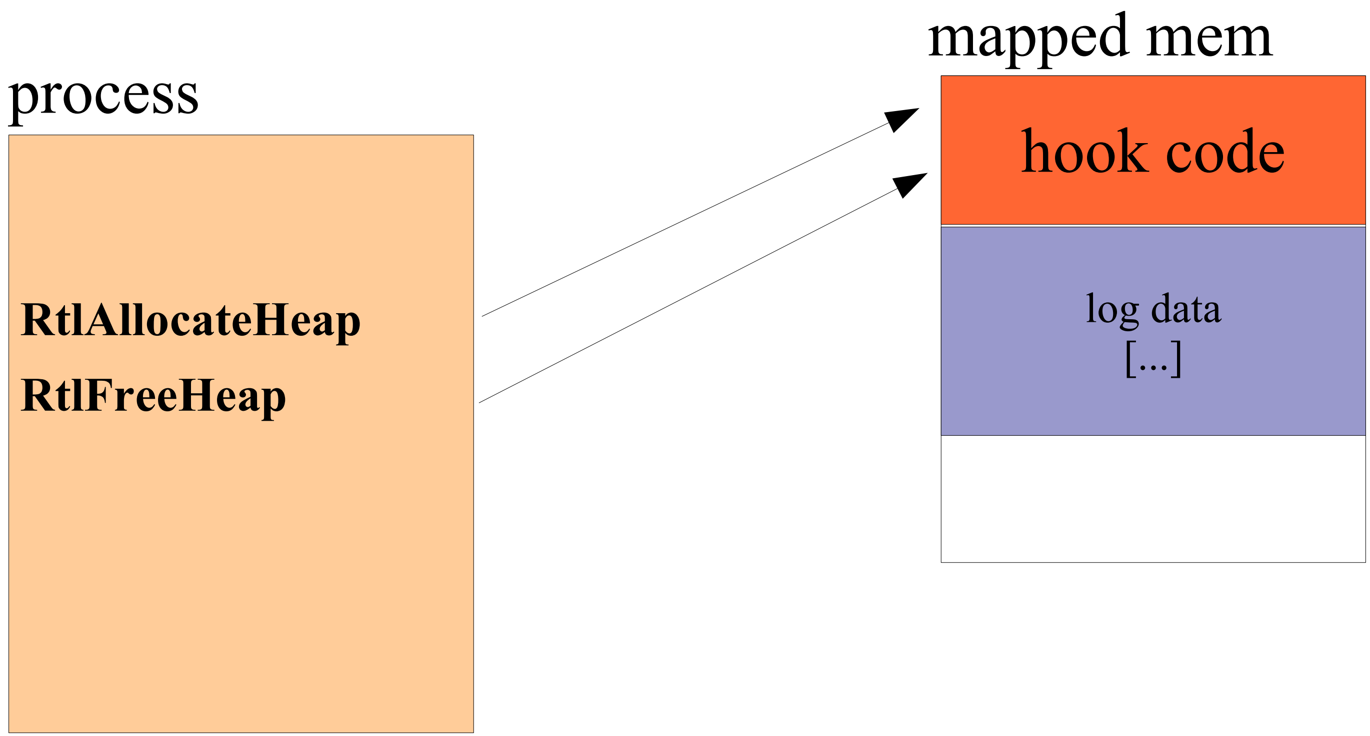
Inject Hook

Redirect Function

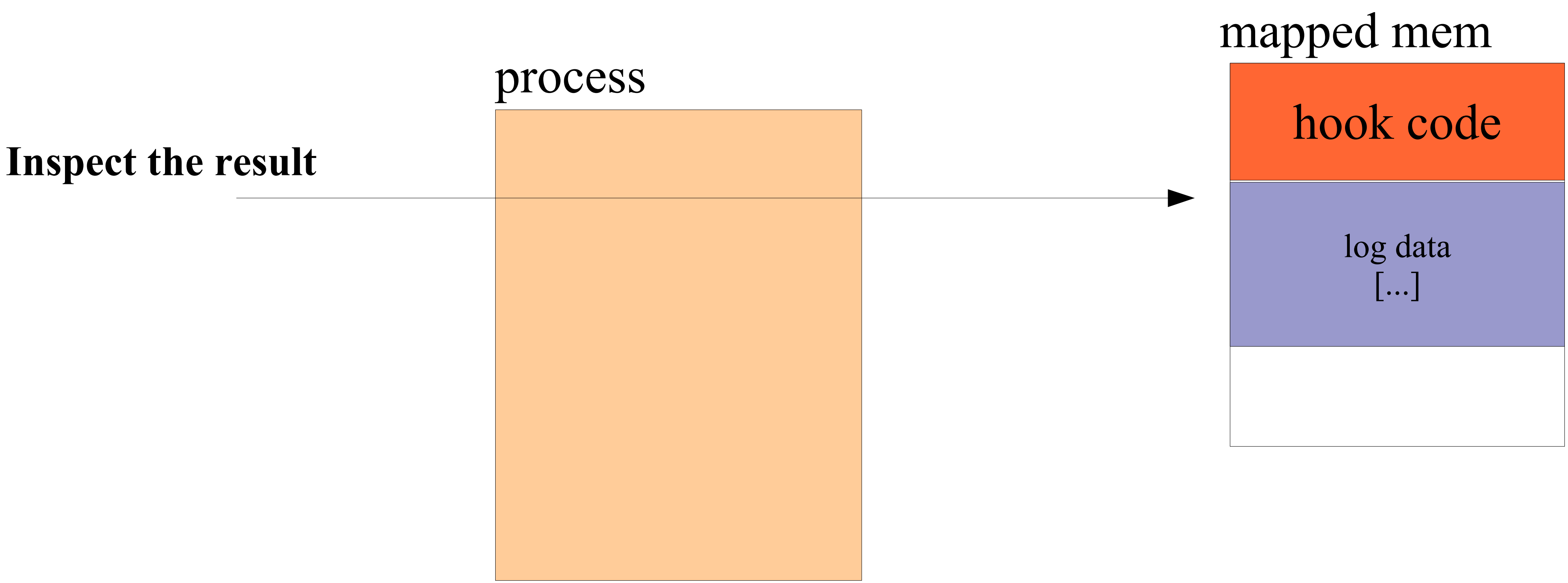


Inject Hook

Run the program



Inject Hook



Inject Hook

- Hooking redirection:
  - !hippie -af -n tag_name
- Hooking redirection as script:

```
fast = immlib.STDCALLFastLogHook( imm )
fast.logFunction( rtlallocate, 3)
fast.logRegister( "EAX" )
fast.logFunction( rtlfree, 3 )
fast.Hook()
```

Finding Function Pointers

- If we achieve our write primitive by overwriting some structure in the data of the chunk (e.g. a doubly linked list, data pointers, etc.) we need to figure out what function pointers are triggered after our write primitive so we can target those function pointers

time line

setting heap layout	overwrite function	Write primitive	Function ptr triggered

Finding Function Pointer

- !modptr <address>
  - this tool will do data type recognition looking for all function pointers on a .data section, overwriting them and hooking on Access Violation waiting for one of them to trigger and logging it

setting heap layout	overwrite function	Write primitive	Function ptr triggered

The future

- In the near future ID will have a heap simulator that, when fed with heap flow fingerprints, will tell you which function calls are needed to get the correct heap layout for your target process
- Simple modifications to existing scripts can put memory access breakpoints at the end of every chunk to find out exactly when a heap overflow happens
  - This is great for fuzzers

Conclusions

- Exploiting heap vulnerabilities has become much more costly
- Immunity Debugger offers tools to drastically reduce the effort needed to write reliable heap overflows
  - On older Windows platforms getting a reliable write4 the traditional way
  - On newer Windows platforms by abusing program-specific data structures

Thank you for your time

Contact me at:

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