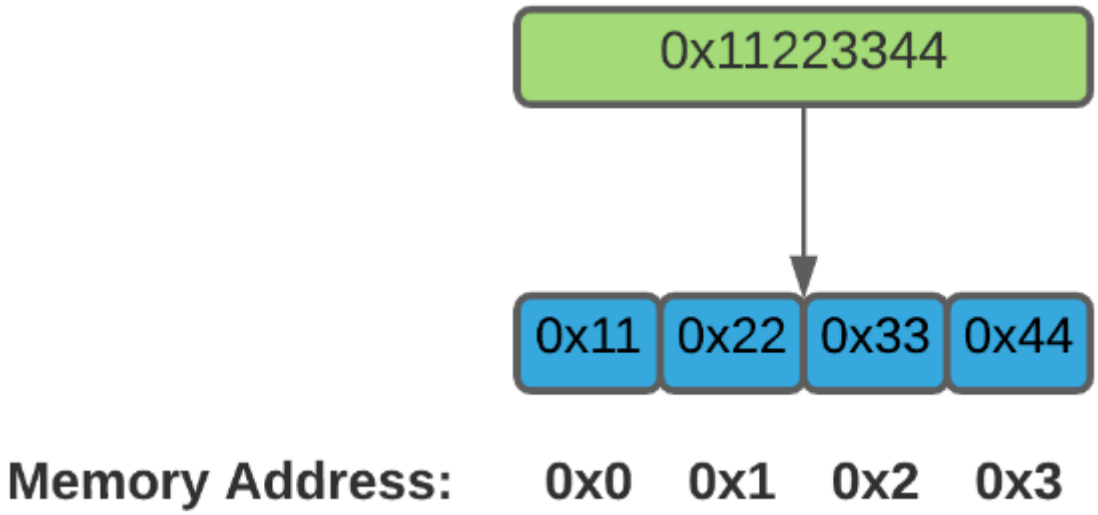
x64

Shellcode

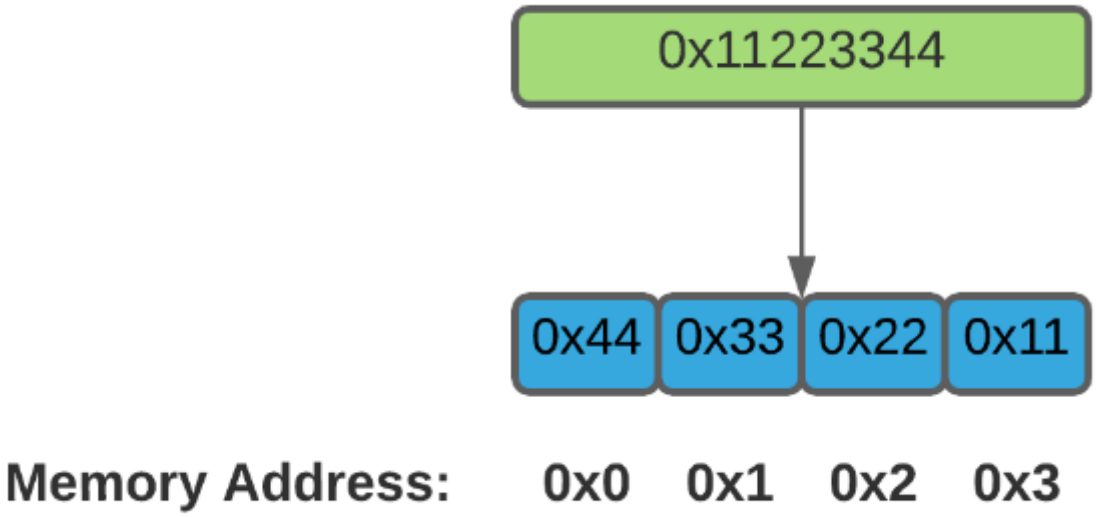
CPU **CPU 1:1** C

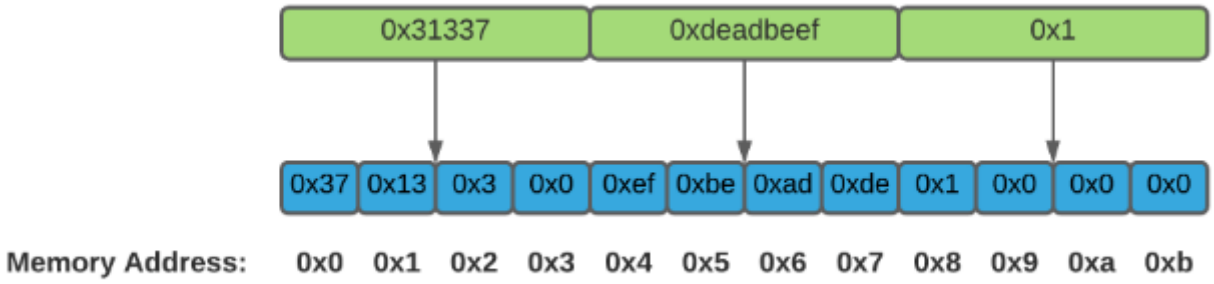
( )



0x11223344 4 0x11 0x22 0x33 0x44

0x11223344 4 0x11 0x22 0x33 0x44





2^64 -1 -2^63 2^63-1 0

1 42 2

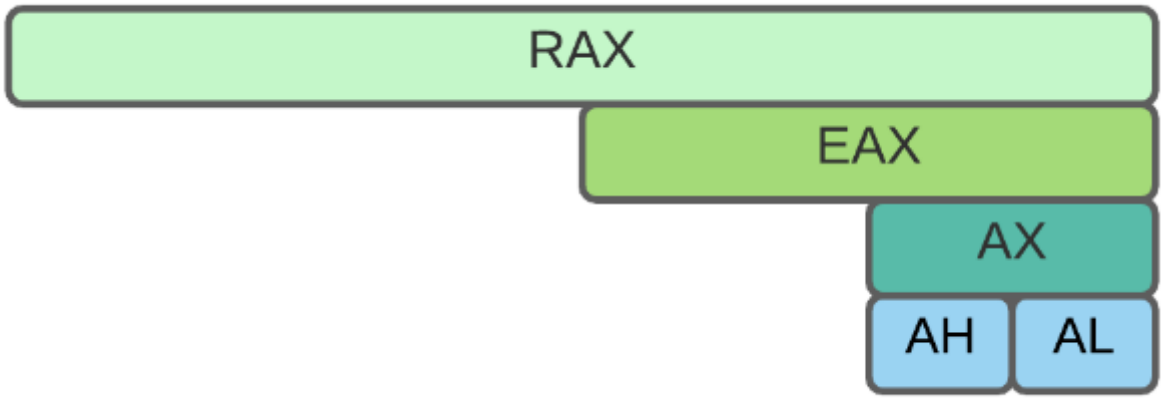
```
42     0000 0000 0000 0000 0000 0000 0000 0000 0000 0000 0000 0000 0000 0000 0010 1010
    1111 1111 1111 1111 1111 1111 1111 1111 1111 1111 1111 1111 1111 1111 1101 0101
1:     1111 1111 1111 1111 1111 1111 1111 1111 1111 1111 1111 1111 1111 1111 1101 0110
```

CPU

(RAM) CPU **64 8** 64 x64

RIP		
RAX	I/O	Windows syscall SSN
RBX		
RCX		
RDX	I/O	
RSI		
RDI		
RBP		
RSP		
R8-R15		
RFLAGS	FLAG	

x64 8 RAX 4 EAX EAX 2 AX AH AL A



R8

32 EAX 32 0 8 16

64 ????	? 32 ?	? 16 ?	? 8 ?
rax	eax	ax	al
rbx	ebx	bx	bl
rcx	ecx	cx	cl
rdx	edx	dx	dl
rsi	esi	si	sil
rdi	edi	di	dil
rbp	ebp	bp	bpl
rsp	esp	sp	spl
r8	r8d	r8w	r8b
r9	r9d	r9w	r9b

64 ????	? 32 ?	? 16 ?	? 8 ?
r10	r10d	r10w	r10b
r11	r11d	r11w	r11b
r12	r12d	r12w	r12b
r13	r13d	r13w	r13b
r14	r14d	r14w	r14b
r15	r15d	r15w	r15b

RFLAGS

0	CF	
2	PF	
6	ZF	
7	SF	
11	OF	

(LIFO)

Windows x64 (*Linux x64* *Windows*) **4 RCX RDX R8 R9** 4

x64 Windows RCX RDX R8 R9

RAX RCX RDX R8 R9 R10 R11

RBX RBP RDI RSI RSP R12 R13 R14 R15

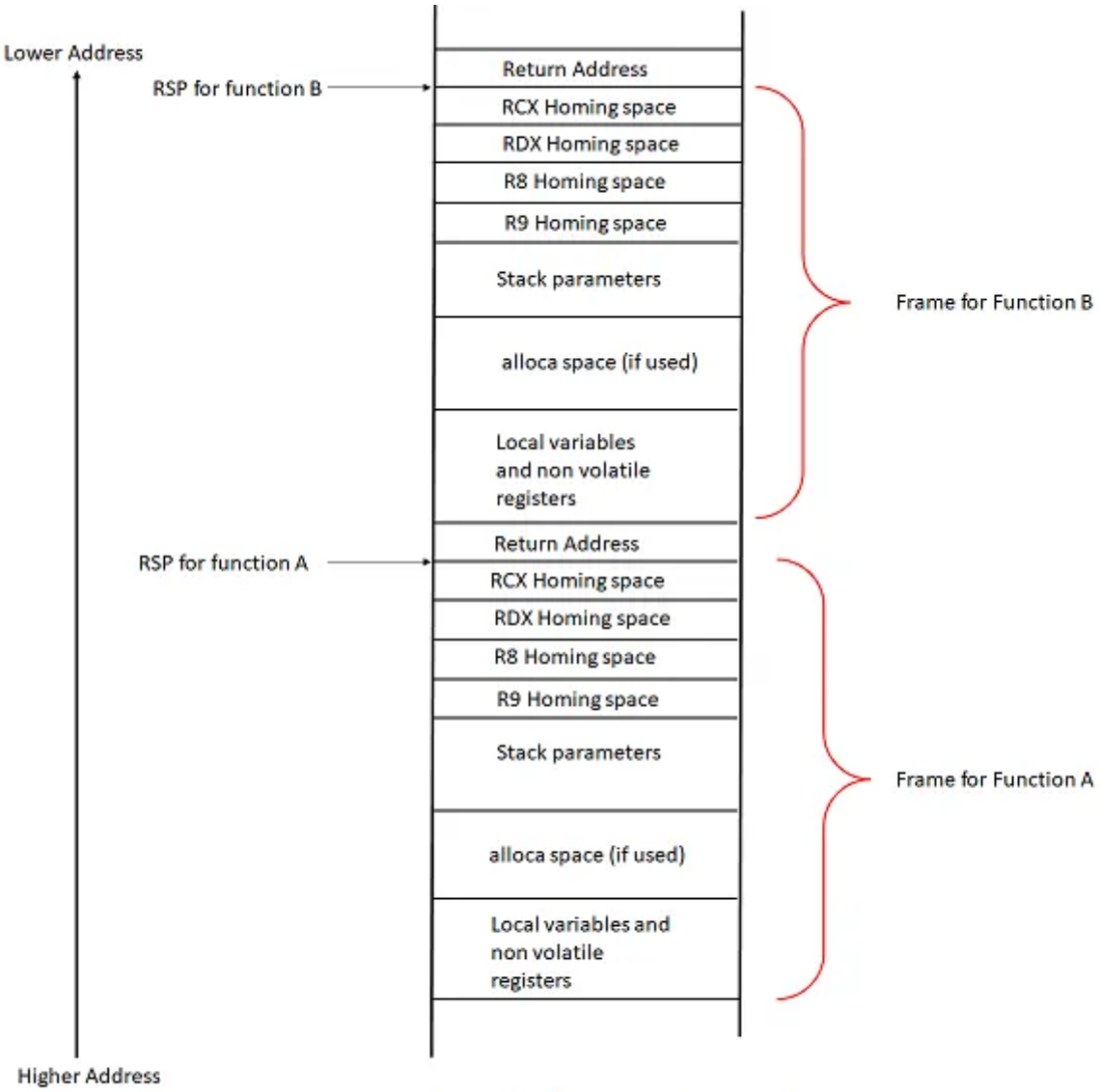
x86 **x64 fastcall PUSH/POP** RSP

) (RIP

(RSP) RSP RSP

(RBP) x64 RSP RSP

A B



Stack frame when function A calls function B

BYTE	1
WORD	2
DWORD	4
QWORD	8

Shellcode

MOV

MOV

```
MOV RAX, 1  //    1   RAX
MOV [RAX], 3  //  3   RAX
MOV RAX, RCX  // RCX     RAX
MOV [RDI], RAX  //  RAX     RDI
MOV [RAX], RAX  //  RAX     RAX
MOV RBX, [RDI + 0x10] //  RDI  10          RBX
```

LEA

LEA MOV

```
LEA RBX, [RCX + 0x10]    // RCX    10    RBX
MOV RBX, [RCX + 0x10]    // RCX    10             RBX
LEA RAX, [RCX + 2*RAX + 0x10]    // RCX + 2*EAX + 10    RAX
```

PUSH/POP

PUSH POP x64 x64 PUSH POP

```
PUSH RAX //  RAX
PUSH 1  //  1
POP RAX  //         RAX
```

INC/DEC/ADD/SUB/MUL/DIV

INC 1 DEC 1 ADD SUB

MUL 1 **RDX:RAX** **MUL RBX** RAX RAX 5 RBX 4 RAX 20 RDX 0

DIV **RDX:RAX** **RAX** **RDX** DIV RBX RDX 0 RAX 20 20 RBX 4 RAX 5

```
INC RAX    // RAX   1
INC BYTE [RAX]    // RAX            1
ADD RAX, RAX   // RAX = RAX + RAX
ADD RCX, 4    // RCX = RCX + 4
ADD DWORD [RSP], RAX    // memory[RSP] = memory[RSP] + RAX
SUB RAX, RDX    // RAX = RAX - RDX
SUB RBX, 0x10    // RBX = RBX - 0x10
MUL RCX    // RDX:RAX = RAX * RCX
MUL DWORD [RDX]    // RDX:RAX = RAX * memory[RDX]
DIV RCX    // RDX:RAX/RCX=RAX···RDX
```

NEG

NEG 0x00

```
NEG RAX  // RAX = -RAX
```

AND/OR/XOR/NOT

```
0 AND 0 = 0
0 AND 1 = 0
1 AND 0 = 0
1 AND 1 = 1

0 OR 0 = 0
0 OR 1 = 1
1 OR 0 = 1
1 OR 1 = 1
```

```
0 XOR 0 = 0
0 XOR 1 = 1
1 XOR 0 = 1
1 XOR 1 = 0

NOT 0 = 1
NOT 1 = 0
```

NOT **ADD RAX, RCX** 2

```
RAX = 0000 0000 0000 0000 0000 0000 0000 0000 0110 0110 0110 0110 0110 0110 0110 0110
RCX = 0000 0000 0000 0000 0000 0000 0000 0000 0011 0011 0011 0011 0011 0011 0011 0011
-------------------------------------------------------------------------------------
RAX = 0000 0000 0000 0000 0000 0000 0000 0000 0010 0010 0010 0010 0010 0010 0010 0010
```

```
AND RAX, RCX  ; RAX = RAX and RCX
XOR RAX, RAX  ; RAX = RAX xor RAX (=0)
NOT RCX       ; RCX = not RCX
AND RCX, 0x11 ; RCX = RCX and 0x11
```

CALL/RET/JMP

JMP 4 RIP JMP JMP

CALL **RET** JMP RIP CALL RET

TEST/CMP/JXX

if-else **AND RFLAGS** TEST CMP TEST ZF **TEST RAX, RAX** RAX 0 (

CMP TEST **CMP RAX RBX** RAX RFLAGS RBX ZF 1

Jxx

```
JE/JZ      / 0
JNE/JNZ     /  0
```

```
JA/JNBE     /   /
JAE/JNB       /
JB/JNAE     /
JBE/JNA       /



JE/JZ       / 0
JNE/JNZ        0
JG/JNLE     /
JGE/JNL       /
JL/JNGE     /
JLE/JNG       /
```

SAL/SAR/SHL/SHR

SAL SAR 1 2^n

SHL SAL SHR SAR ( ) SAR

2

RAX **0xFF SHL RAX, 3**

```
RAX
0000 0000 0000 0000 0000 0000 0000 0000 0000 0000 0000 0000 0000 0000 1111 1111

SHL RAX, 3
0000 0000 0000 0000 0000 0000 0000 0000 0000 0000 0000 0000 0000 0111 1111 1000
```

SHL RAX, 56

```
1111 1000 0000 0000 0000 0000 0000 0000 0000 0000 0000 0000 0000 0000 0000 0000
```

SHL/SHR SAL/SAR

ROL/ROR

ROL/ROR “ ”

```
┌─────────────────┐
1 0 0 0 1 0 0 0 |
 / / / / / / /  |
0 0 0 1 0 0 0 1─┘
```

REP/STOS/SCAS

STOS BYTE WORD DWORD **RDI QWORD** **RAX** RDI 1 RDI 1 QWC

STOS **REP** **RCX** STOS RCX 1 0 REP STOS memset

SCAS (AL AX EAX RAX) DF RDI SCAS RI

x64

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