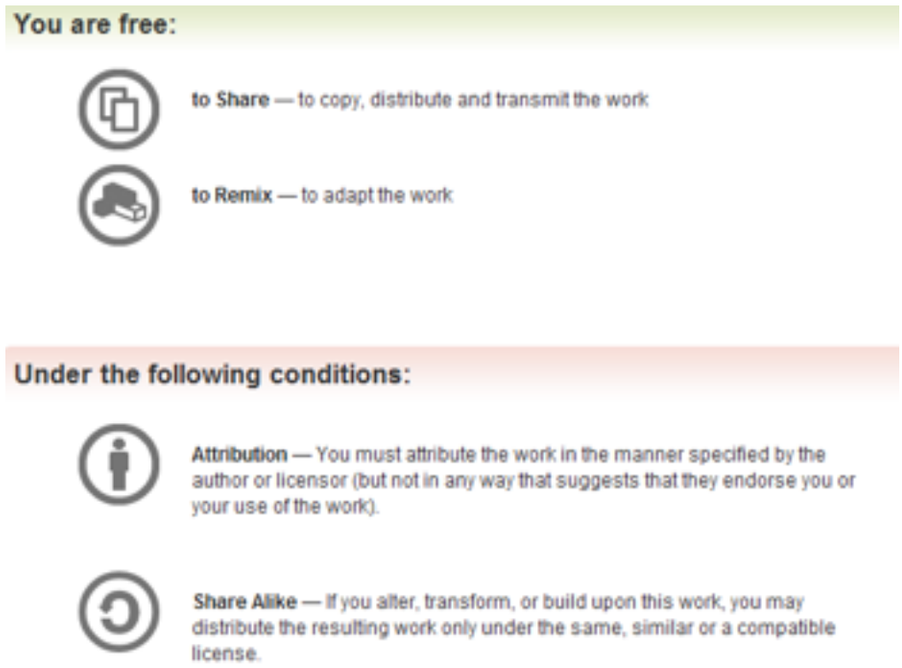
Introduction to Intel x86-64 Assembly, Architecture, Applications, & Alliteration

Xeno Kovah – 2014-2015
xeno@legbacore.com

All materials is licensed under a Creative Commons “Share Alike” license.

- http://creativecommons.org/licenses/by-sa/3.0/



Attribution condition: You must indicate that derivative work
"Is derived from Xeno Kovah's 'Intro x86-64' class, available at http://OpenSecurityTraining.info/IntroX86-64.html"

Attribution condition: You must indicate that derivative work

"Is derived from Xeno Kovah's ‘Intro x86-64’ class, available at http://OpenSecurityTraining.info/IntroX86-64.html"

MulDivExample.c

```
int main(){
        unsigned int a = 1;
        a = a * 6;
        a = a / 3;
        return 0x2bad;
}
```

```
main:
0000000140001010  sub      rsp,18h
0000000140001014  mov      dword ptr [rsp],1
000000014000101B  mov      eax,dword ptr [rsp]
000000014000101E  imul     eax,eax,6
0000000140001021  mov      dword ptr [rsp],eax
0000000140001024  xor      edx,edx
0000000140001026  mov      eax,dword ptr [rsp]
0000000140001029  mov      ecx,3
000000014000102E  div      eax,ecx
0000000140001030  mov      dword ptr [rsp],eax
0000000140001033  mov      eax,2BADh
0000000140001038  add      rsp,18h
000000014000103C  ret
```

We already saw that when a C operand is a power of 2, it uses shifts instead of multiplies/divides, but this shows that in other cases, it uses multiply or divide instructions.

DIV - Unsigned Divide

- Three forms
  - Unsigned divide ax by r/m8, al = quotient, ah = remainder
  - Unsigned divide edx:eax by r/m32, eax = quotient, edx = remainder
  - Unsigned divide rdx:rax by r/m64, rax = quotient, rdx = remainder
- If dividend is 32/64bits, edx/rdx will just be set to 0 by the compiler before the instruction (as occurred in the MulDivExample.c code)
- If the divisor is 0, a divide by zero exception is raised.

initial

operation

result

ax	r/m8(cx)
0x8	0x3

div ax, cx

ah	al
0x2	0x2

edx	eax	r/mX(ecx)
0x0	0x8	0x5

div eax, ecx

edx	eax	r/mX(ecx)
0x3	0x1	0x5

Book page 69

Note that there’s no form which takes an immediate.

IDIV - Signed Divide

- If you were to then change MulDivExample to signed, you would see the IDIV instruction appear
- Three forms
  - Signed divide ax by r/m8, al = quotient, ah = remainder
  - Signed divide edx:eax by r/mX, eax = quotient, edx = remainder
  - Signed divide rdx:rax by r/m64, rax = quotient, rdx = remainder
- If dividend is 32/64bits, edx/rdx will just be set to 0 by the compiler before the instruction
- If the divisor is 0, a divide by zero exception is raised.

initial

operation

result

ax	r/m8(cx)
0xFE	0x2

div ax, cx

ah	al
0x0	0xFF

edx	eax	r/mX(ecx)
0x0	0x8	0x3

div eax, ecx

edx	eax	r/mX(ecx)
0x1	0x2	0x3

Book page 69

Note that there's no form which takes an immediate.

MulDivExample.c takeaways

- When a multiply or divide is <u>not</u> by a power of 2, compilers will use normal multiply/divide instructions
- VS compiler prefers IMUL over MUL (unsigned multiply) for simple multiplies, due to its option to use 3 parameters

```
int main(){
        unsigned int a = 1;
        a = a * 6;
        a = a / 3;
        return 0x2bad;
}
```

```
main:
0000000140001010  sub     rsp,18h
0000000140001014  mov     dword ptr [rsp],1
000000014000101B  mov     eax,dword ptr [rsp]
000000014000101E  imul    eax,eax,6
0000000140001021  mov     dword ptr [rsp],eax
0000000140001024  xor     edx,edx
0000000140001026  mov     eax,dword ptr [rsp]
0000000140001029  mov     ecx,3
000000014000102E  div     eax,ecx
0000000140001030  mov     dword ptr [rsp],eax
0000000140001033  mov     eax,2BADh
0000000140001038  add     rsp,18h
000000014000103C  ret
```

We already saw that when a C operand is a power of 2, it uses shifts instead of multiplies/divides, but this shows that in other cases, it uses multiply or divide instructions.

Instructions we now know (28)

- NOP
- PUSH/POP
- CALL/RET
- MOV
- ADD/SUB
- IMUL
- MOVZX/MOVSX
- LEA
- JMP/Jcc (family)
- CMP/TEST
- AND/OR/XOR/NOT
- INC/DEC
- SHR/SHL/SAR/SAL
- DIV/IDIV