x86-64 Integer Registers

%rax	%eax	%r8	%r8d
%rbx	%ebx	%r9	%r9d
%rcx	%ecx	%r10	%r10d
%rdx	%edx	%r11	%r11d
%rsi	%esi	%r12	%r12d
%rdi	%edi	%r13	%r13d
%rsp	%esp	%r14	%r14d
%rbp	%ebp	%r15	%r15d

(not pictured: `%rip` = PC)

Operand Combinations

	Source	Dest	Src, Dest	C Analog
movq	*Imm*	*Reg*	`movq $0x4,%rax`	`temp = 0x4;`
		Mem	`movq $-147,(%rax)`	`*p = -147;`
	Reg	*Reg*	`movq %rax,%rdx`	`temp2 = temp1;`
		Mem	`movq %rax,(%rdx)`	`*p = temp;`
	Mem	*Reg*	`movq (%rax),%rdx`	`temp = *p;`

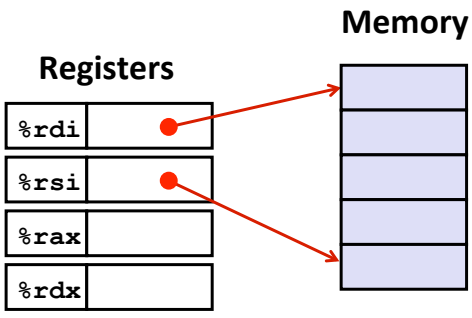
Addressing Example

```
void swap(long *xp, long *yp) {
  long t0 = *xp;
  long t1 = *yp;
  *xp = t1;
  *yp = t0;
}
```

```
swap:
    movq    (%rdi), %rax
    movq    (%rsi), %rdx
    movq    %rdx, (%rdi)
    movq    %rax, (%rsi)
    ret
```


Understanding Swap

```
void swap
    (long *xp, long *yp)
{
  long t0 = *xp;
  long t1 = *yp;
  *xp = t1;
  *yp = t0;
}
```



Register	Value
%rdi	xp
%rsi	yp
%rax	t0
%rdx	t1

```
swap:
    movq    (%rdi), %rax  # t0 = *xp
    movq    (%rsi), %rdx  # t1 = *yp
    movq    %rdx, (%rdi)  # *xp = t1
    movq    %rax, (%rsi)  # *yp = t0
    ret
```

General Memory Addressing

- Most General Form

```
D(Rb,Ri,S)      Mem[D + Reg[Rb]+S*Reg[Ri]]
```

  - `D` Constant "displacement"
  - `Rb` Base register
  - `Ri` Index register
  - `S` Scale: 1, 2, 4, or 8

- Special cases

```
(Rb,Ri)          Mem[Reg[Rb]+Reg[Ri]]
D(Rb,Ri)         Mem[D + Reg[Rb]+Reg[Ri]]
(Rb,Ri,S)        Mem[Reg[Rb]+S*Reg[Ri]]
(,Ri,S)          Mem[S*Reg[Ri]]
D(,Ri,S)         Mem[D + S*Reg[Ri]]
```


Arithmetic Operations

`addq`	*Src,Dest*	Dest = Dest + Src	
`subq`	*Src,Dest*	Dest = Dest - Src	
`imulq`	*Src,Dest*	Dest = Dest * Src	
`sarq`	*Src,Dest*	Dest = Dest >> Src	***Arithmetic RShift***
`shrq`	*Src,Dest*	Dest = Dest >> Src	***Logical RShift***
`salq`	*Src,Dest*	Dest = Dest << Src	***Also called shlq***
`xorq`	*Src,Dest*	Dest = Dest ^ Src	
`andq`	*Src,Dest*	Dest = Dest & Src	
`orq`	*Src,Dest*	Dest = Dest | Src	
`incq`	*Dest*	*Dest = Dest + 1*	
`decq`	*Dest*	*Dest = Dest - 1*	
`negq`	*Dest*	*Dest = -Dest*	
`notq`	*Dest*	*Dest = ~Dest*	
`leaq`	*Src,Dest*	Dest = Src (as expr)	***No memory access!***

Arithmetic Example

```
long arith
(long x, long y, long z)
{
  long t1 = x+y;
  long t2 = z+t1;
  long t3 = x+4;
  long t4 = y * 48;
  long t5 = t3 + t4;
  long rval = t2 * t5;
  return rval;
}
```

```
(x,y,z) -> (%rdi,%rsi,%rdx)

arith:
   leaq    (%rdi,%rsi), %rax
   addq    %rdx, %rax
   leaq    (%rsi,%rsi,2), %rdx
   salq    $4, %rdx
   leaq    4(%rdi,%rdx), %rcx
   imulq   %rcx, %rax
   ret
```


Procedure Call Registers