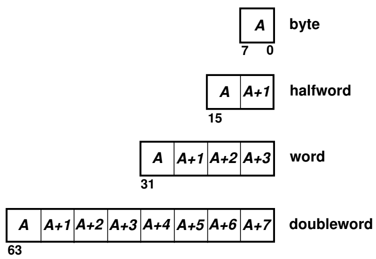
SPARC Architecture

- 8-bit cell (byte) is smallest addressable unit
- 32-bit addresses, i.e., 32-bit virtual address space
- Larger sizes: at address ***A***



- SPARC is a ***big-endian*** (big end, or most-significant end, first) machine

SPARC Registers

- 32, 32-bit wide general-purpose registers

	`%r0 … %r31`	
`%g0 … %g7`	`%r0 … %r7`	global
`%o0 … %o7`	`%r8 … %r15`	output
`%l0 … %l7`	`%r16 … %r23`	local
`%i0 … %i7`	`%r24 … %r31`	input

- The groups relate to procedure calling conventions
- Some registers have ***dedicated uses***

`%sp` (`%r14`)	stack pointer
`%fp` (`%r30`)	frame pointer
`%r15`	temporary
`%r31`	return address

- Register `%g0` always has the value 0 when read; writing it has no effect
- Other special registers (manipulated by special instructions):
  floating point registers (`%f0`…`%f31`)
  program counter (`pc`)
  next program counter (`npc`)
  PSR, **TBR**, **WIM**, **Y**

SPARC Register Map

- see page 193 in the SPARC Architecture Manual, §2.2 in Paul

	`%i7`	`%r31`	**return address - 8**
	`%i6, %fp`	`%r30`	**frame pointer**
in	`%i5`	`%r29`	**incoming parameter 6**
	…	…	…
	`%i0`	`%r24`	**incoming parameter 1/return value *to* caller**
	`%l7`	`%r23`	**local 7**
local	…	…	…
	`%l0`	`%r16`	**local 0**
	`%o7`	`%r15`	**temporary value/address of `call` instruction**
	`%o6, %sp`	`%r14`	**stack pointer**
out	`%o5`	`%r13`	**outgoing parameter 6**
	…	…	…
	`%o0`	`%r8`	**outgoing parameter 1/return value *from* caller**
	`%g7`	`%r7`	**global 7**
global	…	…	…
	`%g1`	`%r1`	**temporary value**
	`%g0`	`%r0`	**0**

SPARC Register Map, cont'd

- Other registers

	`%y`		**Y register**
state	`%psr`		**integer condition codes**
	`%fsr`		**floating point condition codes**
	`%csr`		**coprocessor condition codes**
	`%f31`		**floating point value**
float-ing point	…	…	…
	`%f0`		**floating point value**

- Register save conventions: what happens across calls?

`%g2 … %g7`	saved?
`%g1`	destroyed
`%o0 … %o5, %o7`	destroyed
`%o6`	saved
`%l0 … %l7`	saved
`%i0 … %i7`	saved
`%f0 … %f31`	saved

SPARC Instruction Set

- Instruction groups

  load/store instructions
  integer arithmetic and bitwise logical instructions
  control instructions (branches, calls)
  special instructions (operating system)
  floating point arithmetic and conversion

- Instruction formats (see page 44, Ch. 8 in Paul)

  format 1 (*op* = 1): `call`

op	*disp30*
31	29

  format 2 (*op* = 0): `sethi` and branches (`bi`*cc*, `fb`*fcc*, `cb`*ccc*)

op	*rd*		*op2*	*imm22*
op	*a*	*cond*	*op2*	*disp22*
31	29	28	24	21

  format 3 (*op* = 2 or 3): remaining instructions

op	*rd*	*op3*	*rs1*	*i=0*	*asi*	*rs2*
op	*rd*	*op3*	*rs1*	*i=1*	*simm13*	
op	*rd*	*op3*	*rs1*	*opf*		*rs2*
31	29	24	18	13	12	4

Assembly vs. Machine Language

- ***Machine language*** is the ***bit patterns*** that represent instructions
- ***Assembly language*** is a ***symbolic representation*** of machine language
- ***Assemblers*** translate from assembly language to machine language

  `add %i1,360,%o2` is a format 3 instruction: **`022401460550`**

2	*10*	*0*	*25*	*1*	*360*
31	29	24	18	13	12
2	*12*	*0*	*31*	*1*	*550 octal*

- Assemblers: map an assembly instruction to a machine instruction (usually 1-to-1)
- Compilers: mapping a statement to 1 or many assembly instructions
- ***Disassemblers*** translate from machine language to ***an*** assembly language

Load Instructions

- Load: move data from memory to a register

$$\texttt{ld}\begin{bmatrix}\texttt{u}\\ \texttt{s}\end{bmatrix}\begin{bmatrix}\texttt{b}\\ \texttt{h}\\ \texttt{d}\end{bmatrix}\{\texttt{a}\}\quad \texttt{[}address\texttt{]}, reg$$

alternate address space (privileged)
signed or unsigned
byte, halfword, word, double

- Fetched byte or halfword appears right-justified in the 32-bit register
- Leftmost bits are zero-filled (u) or sign-extended (s)
- A double word is loaded into a register ***pair*** **and** reg must be even

  the most-significant word lands in reg
  the least-significant word in $reg + 1$

- Addresses must be ***aligned***: for address A

halfword	$A \bmod 2 = 0$
word	$A \bmod 4 = 0$
double word	$A \bmod 8 = 0$

Store Instructions

- Move data from a register to memory

$$\texttt{st}\begin{bmatrix}\texttt{b}\\ \texttt{h}\\ \texttt{d}\end{bmatrix}\{\texttt{a}\}\quad reg, \texttt{[}address\texttt{]}$$

alternate address space (privileged)
byte, halfword, word, doubleword

- Storing bytes and halfwords

  the rightmost bits are stored
  the leftmost bits are ignored

- Storing double words

  reg must be even

Addressing Modes

- SPARC has two ***addressing modes*** to yield an ***effective address***
  1. add the contents of two registers
  2. add the contents of a register and a signed, 13-bit number
- Common names
  1. register indirect or deferred
     `ld [%o1],%o2`
  1. register indexed (above is a special case that uses `%g0`)
     `st %o1,[%o2+%o3]`
  2. register displacement or based
     `ld [%o1+10],%o2`
- Assembly-language syntax: *N* is a 13-bit integer constant

address	*synonym*
reg	*reg* + `%g0`
reg + *reg*	
reg + *N*	
N + *reg*	*reg* + *N*
N	`%g0` + *N*