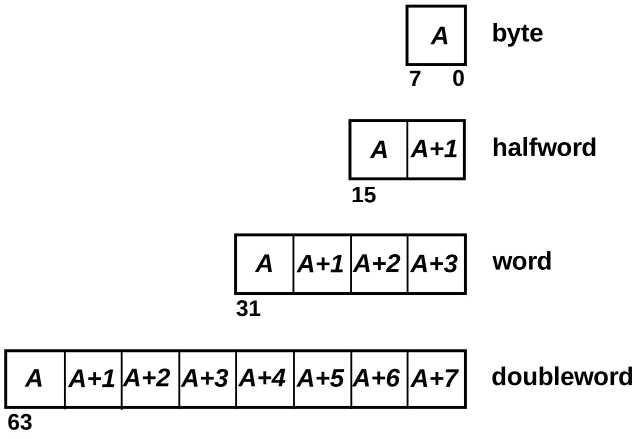
SPARC Architecture

- 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 §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 Ch. 8 in Paul)

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

op	*disp30*
31	**29**

  format 2 (*op* = 0): **`sethi`** and branches (**`b`*`icc`***, **`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*

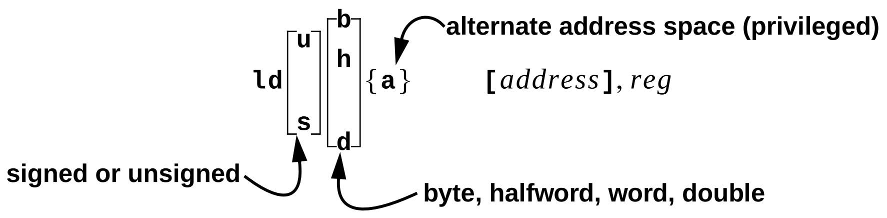
- Assemblers: mapping an assembly instruction to a machine instruction (1-to-1)

- 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


ld
u
s
b
h
d
{a}
[address], 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 or sign-extended
- A double word is loaded into a register ***pair*** **and** *reg* must be even

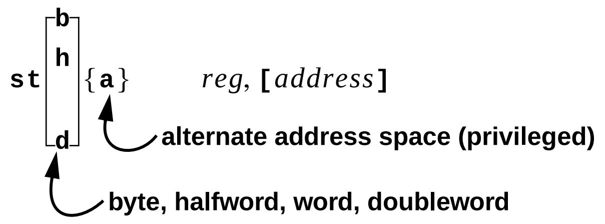
  the most-significant word lands in *reg*

  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


st
b
h
d
{a}
reg, [address]
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***