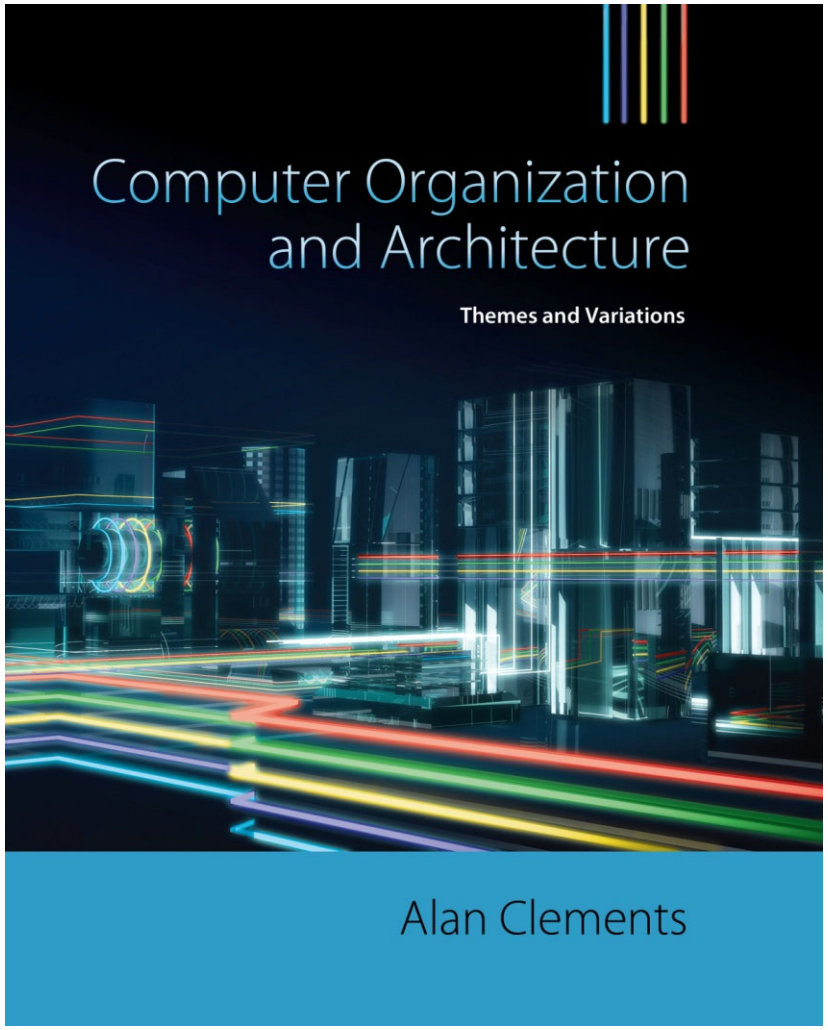
Part 9

CHAPTER 3

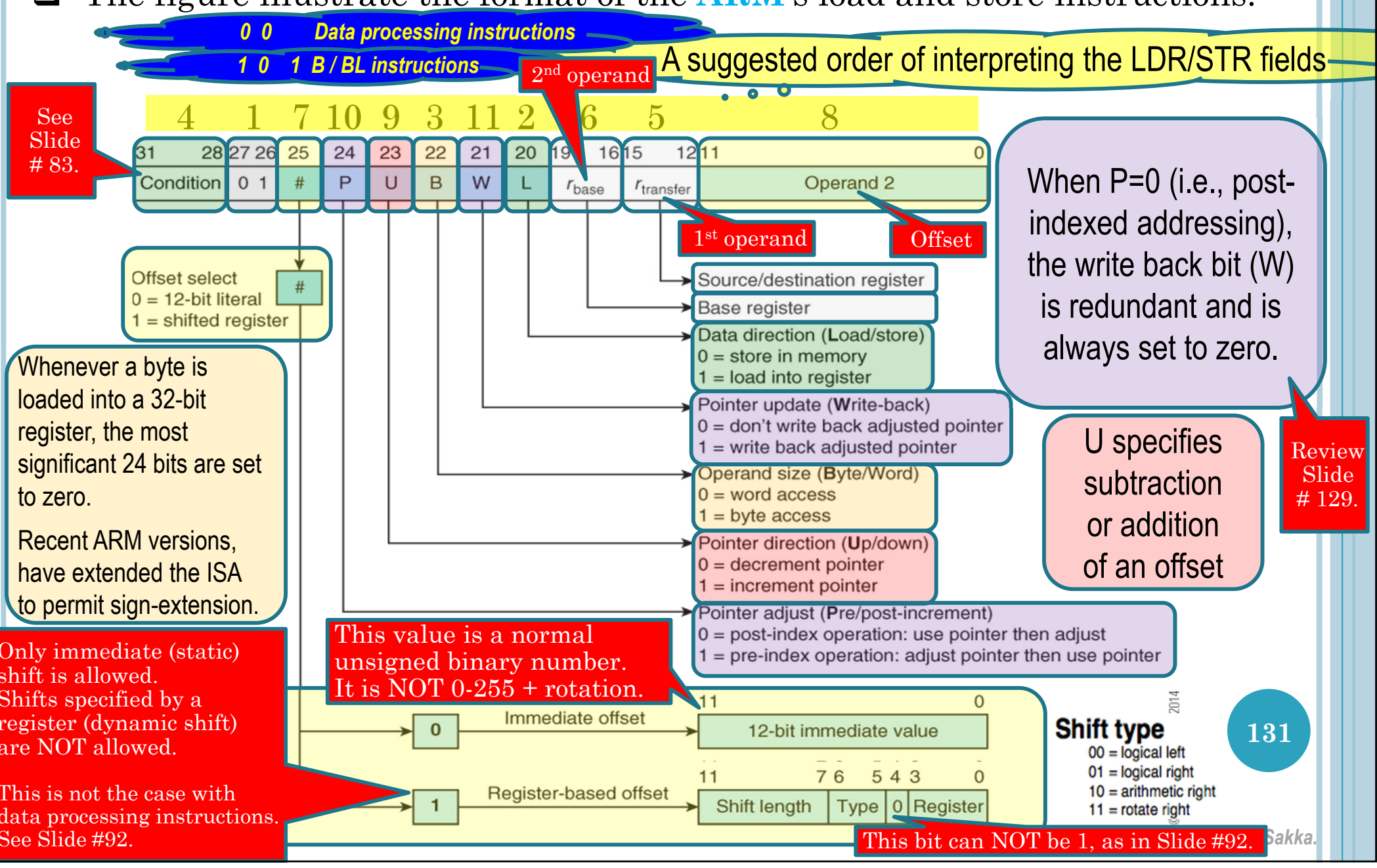
Architecture and Organization



CENGAGE Learning

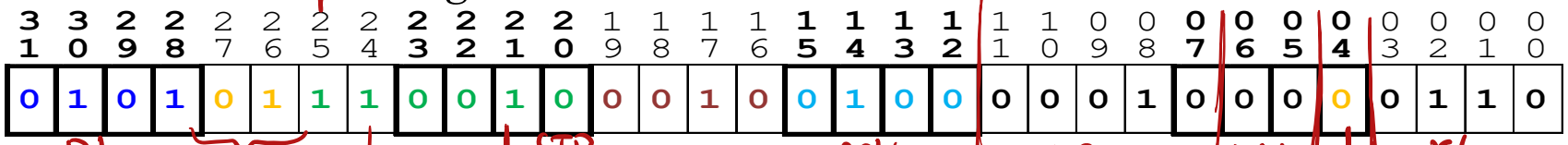
ARM Load and Store Encoding

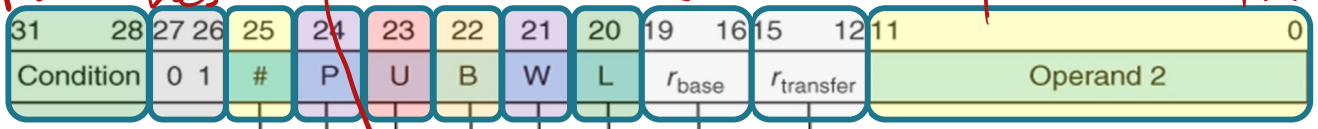
- The figure illustrate the format of the **ARM**'s load and store instructions.



ARM Load and Store Encoding

- Decode the following ARM machine code instruction **0x57224106**





Offset select
0 = 12-bit literal
1 = shifted register

Source/destination register

Base register

Data direction (**L**oad/store)
0 = store in memory
1 = load into register

Pointer update (**W**rite-back)
0 = don't write back adjusted pointer
1 = write back adjusted pointer

Operand size (**B**yte/Word)
0 = word access
1 = byte access

Pointer direction (**U**p/down)
0 = decrement pointer
1 = increment pointer

Pointer adjust (**P**re/post-increment)
0 = post-index operation: use pointer then adjust
1 = pre-index operation: adjust pointer then use pointer

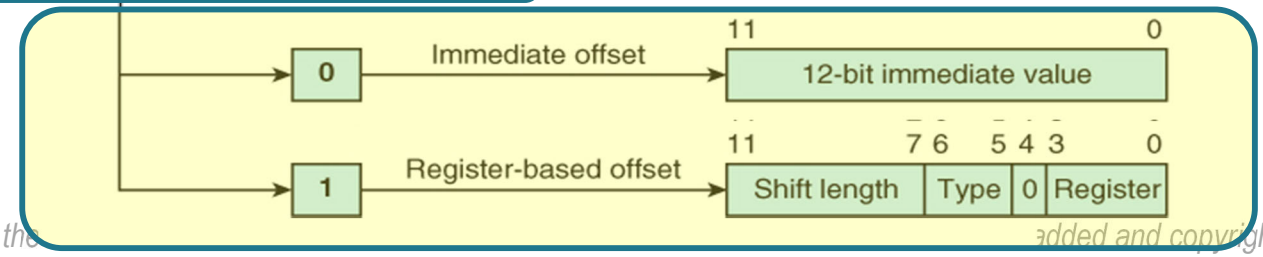
When P=0 (i.e., post-indexed addressing), the write back bit (W) is redundant and is always set to zero.

U specifies subtraction or addition of an offset

Whenever a byte is loaded into a 32-bit register, the most significant 24 bits are set to zero.

Recent ARM versions, have extended the ISA to permit sign-extension.

```
STRPL r4, [r2, -r6,LSL #2]!
```



Shift type
00 = logical left
01 = logical right
10 = arithmetic right
11 = rotate right

ARM Load and Store Encoding

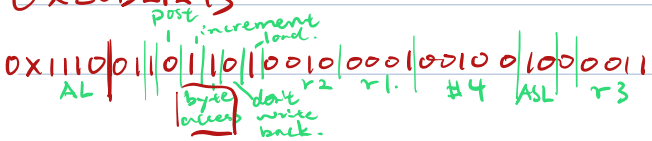
Decoding the ARM Instruction **STRPL r4,[r2,-r6,LSL#2]!**

Field Name	Value	Action	Interpretation
Condition	0101	PL	Execute on positive
OP-code	01		Defines load/store instruction
#	1	Operand 2 format	Operand is a shifted register
P	1	Pre/post adjust	Adjust pointer before using
U	0	Pointer direction	Decrement pointer
B	0	Byte/word	This is a word access
W	1	Pointer write back	Update pointer after use
L	0	Load/store	Store data in memory
r_{base}	0010	Base register	r2 is the base (pointer) register
$r_{transfer}$	0100	Source/destination	r4 is the source in this store instruction
Shift length	00010	Shift length	Shift the register 2 places
Shift type	00	Logical shift left	Logical shift left the offset in r6
Op-code	0		
Shift register	0110	Specified register to be shifted	r6 is shifted twice

Operand 2

0xE6D21243

post increment load.



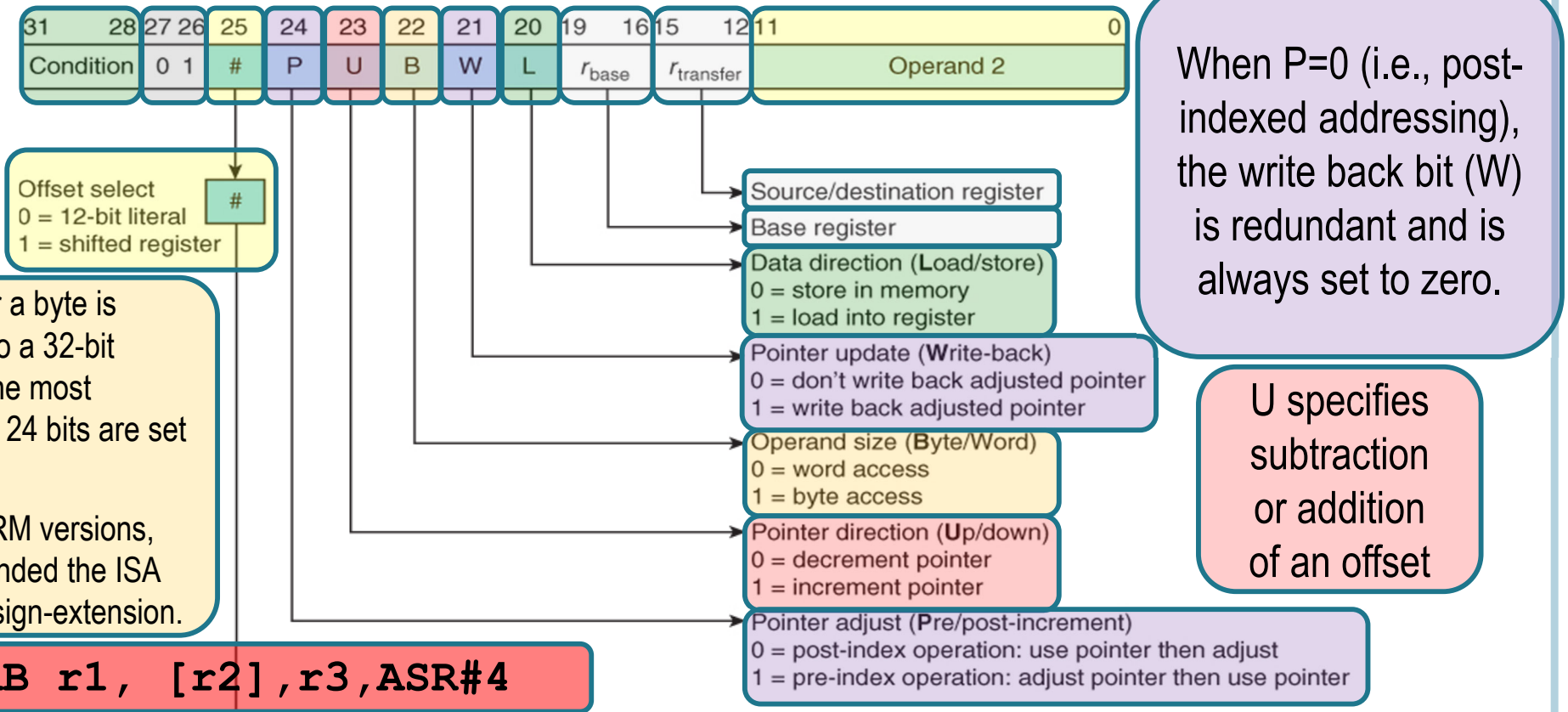
LDRB.r1, [r2], r3, ASL #4.

byte access.

ARM Load and Store Encoding

- Decode the following ARM machine code instruction **0xE6D21243**

31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
1	1	1	0	0	1	1	0	1	1	0	1	0	0	1	0	0	0	0	1	0	0	1	0	0	1	0	0	0	0	1	1



When P=0 (i.e., post-indexed addressing), the write back bit (W) is redundant and is always set to zero.

U specifies subtraction or addition of an offset

Whenever a byte is loaded into a 32-bit register, the most significant 24 bits are set to zero.

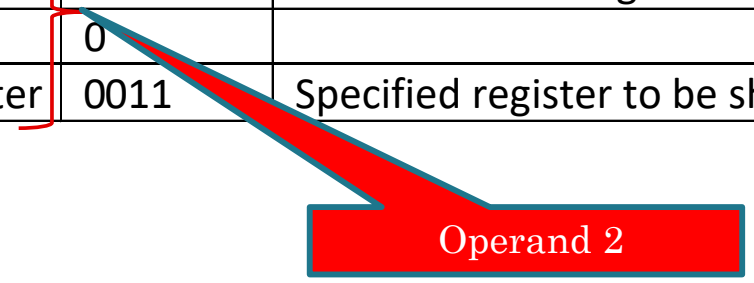
Recent ARM versions, have extended the ISA to permit sign-extension.

```
LDRB r1, [r2],r3,ASR#4
```

ARM Load and Store Encoding

Decoding the ARM Instruction **LDR r1, [r2],r3,ASR#4**

Field Name	Value	Action	Interpretation
Condition	1110	AL	Always (default)
OP-code	01		Defines load/store instruction
#	1	Operand 2 format	Operand is a shifted register
P	0	Pre/post adjust	Adjust pointer after using
U	1	Pointer direction	Increment pointer
B	0	Byte/word	This is a word access
W	0	Pointer write back	As P=0, W is redundant and always=0
L	1	Load/store	Load data from memory
r_{base}	0010	Base register	r2 is the base (pointer)register
$r_{transfer}$	0001	Source/destination	r1 is the destination in this loadinstruction
Shift length	00100	Shift length	Shift the register 4 places
Shift type	10	Arithmetic shift right	Arithmetic shift right the offset in r3
Op-code	0		
Shift register	0011	Specified register to be shifted	r3 is shifted four times



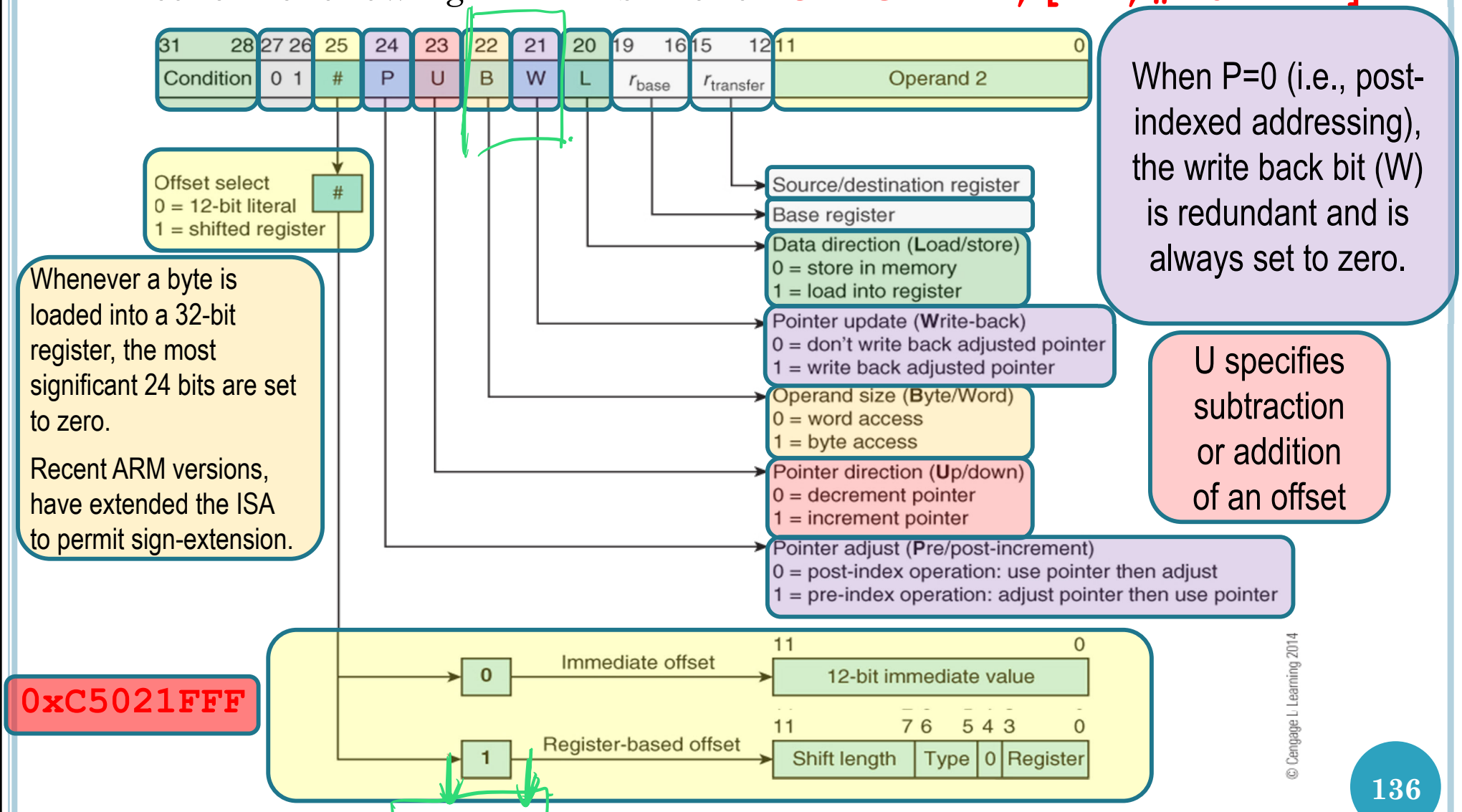
STRGT r1, [r2, #-0xFFF]

1100|0101|0|01|0010|0001|1111|1111|1111

0xC5521FFF

ARM Load and Store Encoding

- Encode the following ARM instruction **STRGT r1,[r2,#-0xFFF]**



When P=0 (i.e., post-indexed addressing), the write back bit (W) is redundant and is always set to zero.

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Recent ARM versions, have extended the ISA to permit sign-extension.

0xC5021FFF

31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16	15	14	13	12	11	10	09	08	07	06	05	04	03	02	01	00
1	1	0	0	0	1	0	1	0	0	0	0	0	0	1	0	0	0	0	1	1	1	1	1	1	1	1	1	1	1	1	1

ARM Load and Store Encoding

Decoding the ARM Instruction **STRGT r1,[r2,#-0xFFF]**

Field Name	Value	Action	Interpretation
Condition	1100	GT	Execute on greater than
OP-code	01		Defines load/store instruction
#	0	Operand 2 format	Operand is immediate
P	1	Pre/post adjust	Adjust pointer before using
U	0	Pointer direction	Decrement pointer
B	0	Byte/word	This is a word access
W	0	Pointer write back	Do not write back the adjusted pointer
L	0	Load/store	Store data in memory
r_{base}	0010	Base register	r2 is the base (pointer) register
$r_{transfer}$	0001	Source/destination	r1 is the source in this store instruction
Immediate offset	111111111111	Shift length	Offset value = 0xFFF

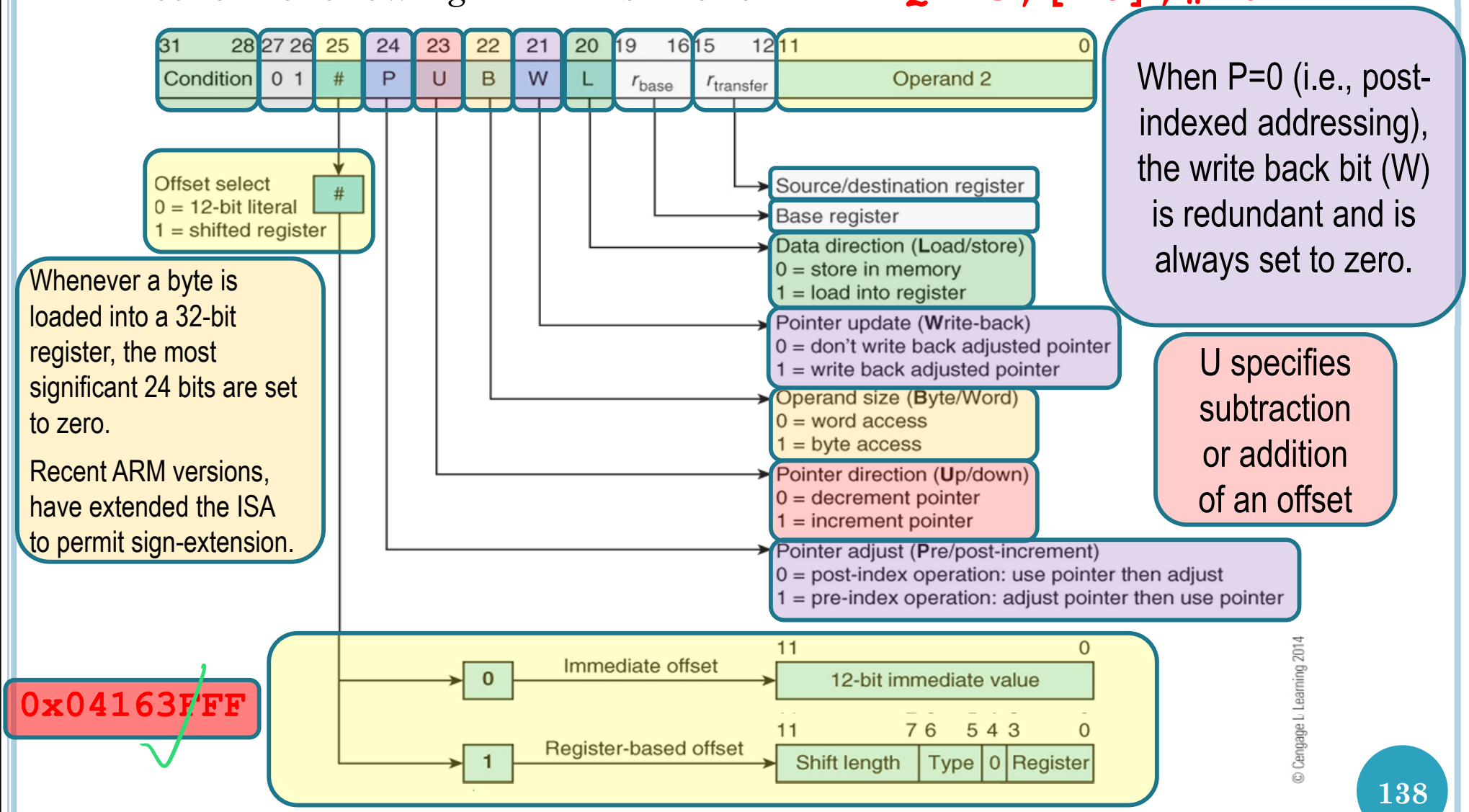
LDREQ r3, [r6], #-0xFFF

0000|0100|0001|0110|0011|FFF

0x04163FFF

ARM Load and Store Encoding

- Encode the following ARM instruction **`LDREQ r3,[r6],#-0xFFF`**



When P=0 (i.e., post-indexed addressing), the write back bit (W) is redundant and is always set to zero.

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Whenever a byte is loaded into a 32-bit register, the most significant 24 bits are set to zero.

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0x04163FFF

31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16	15	14	13	12	11	10	09	08	07	06	05	04	03	02	01	00
0	0	0	0	0	1	0	0	0	0	0	1	0	1	1	0	0	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1

ARM Load and Store Encoding

Decoding the ARM Instruction **LDREQ r3,[r6],#-0xFFF**

Field Name	Value	Action	Interpretation
Condition	0000	EQ	Execute on equal
OP-code	01		Defines load/store instruction
#	0	Operand 2 format	Operand is immediate
P	0	Pre/post adjust	Adjust pointer after using
U	0	Pointer direction	Decrement pointer
B	0	Byte/word	This is a word access
W	0	Pointer write back	Write back adjusted pointer
L	1	Load/store	Load data from memory
r_{base}	0110	Base register	r6 is the base (pointer) register
$r_{transfer}$	0011	Source/destination	r3 is the destination in this load instruction
Immediate offset	111111111111	Shift length	Offset value = 0xFFF

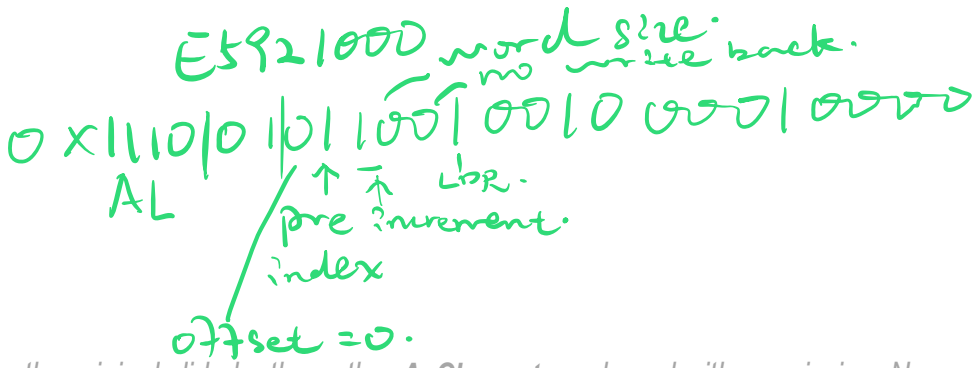
ARM Load and Store Encoding

- Encode the following **ARM** instructions.

```
LDR R1,[R2]
LDR R1,[R2],#0
LDR R1,[R2,#0]
LDR R1,[R2,#0]!

STR R1,[R2]
STR R1,[R2],#0
STR R1,[R2,#0]
STR R1,[R2,#0]!
```

- Is there any *effective* difference between the 4 LDR instructions?
- Is there any *effective* difference between the 4 STR instructions?



```
LDR R1,[R2]
LDR R1,[R2],#0
LDR R1,[R2,#0]
LDR R1,[R2,#0]!
```

These two work the same way.

D:77 : post-index : #24=0

Literal in brackets indicating pre-index.

D:77 : write back : #24=1.

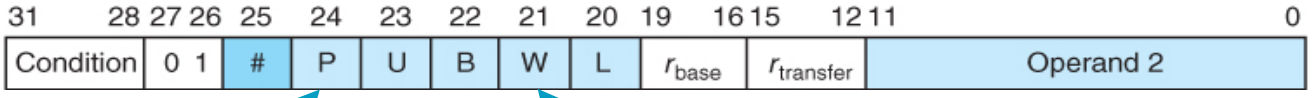
write back.

ToDo - Later

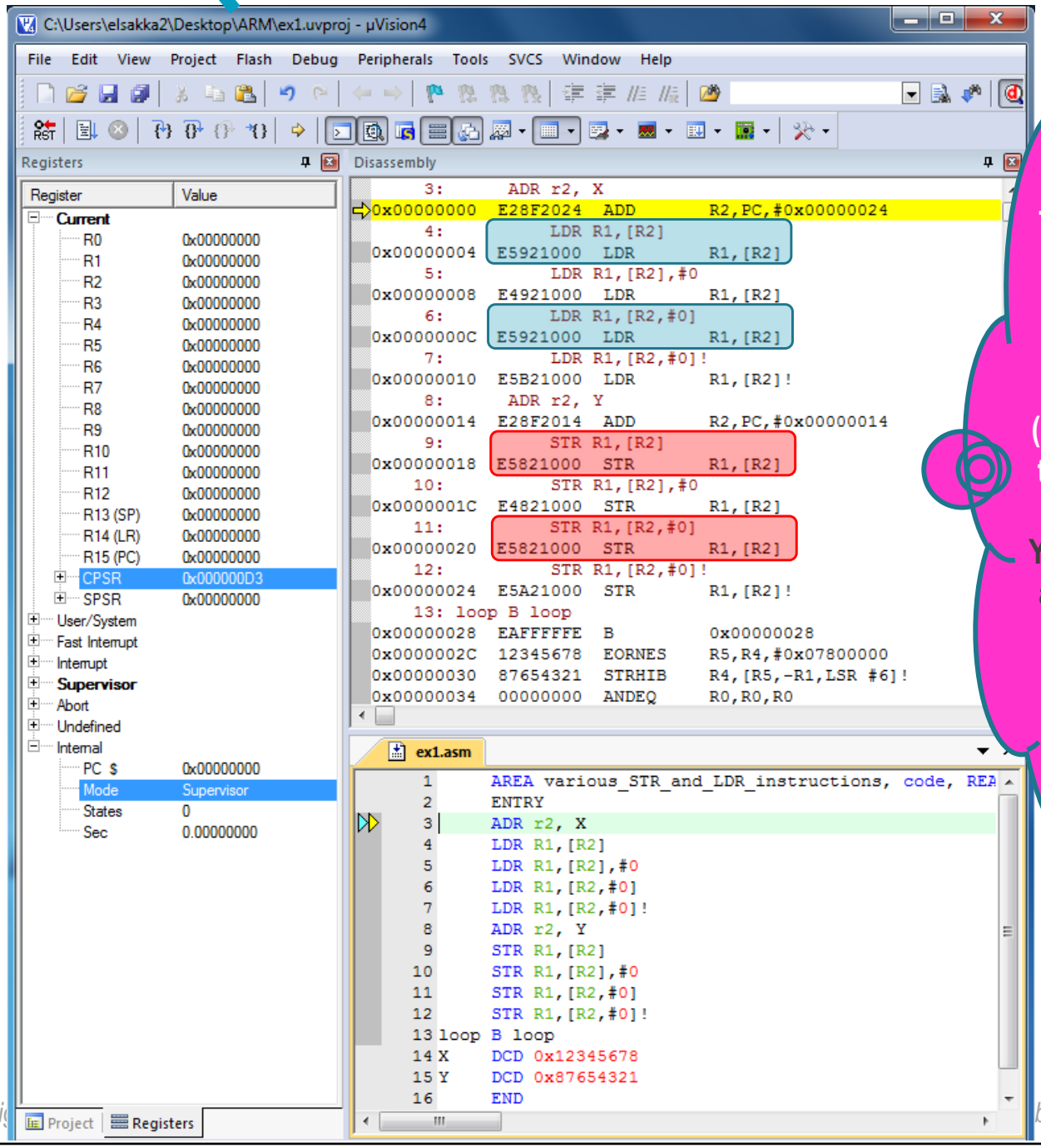
```
STR R1,[R2]
STR R1,[R2],#0
STR R1,[R2,#0]
STR R1,[R2,#0]!
```

ARM Load and Store Encoding

```
      AREA various_STR_and_LDR_instructions, code, READONLY
      ENTRY
      ADR r2, X
      LDR R1,[R2]
      LDR R1,[R2],#0
      LDR R1,[R2,#0]
      LDR R1,[R2,#0]!
      ADR r2, Y
      STR R1,[R2]
      STR R1,[R2],#0
      STR R1,[R2,#0]
      STR R1,[R2,#0]!
loop  B loop
X     DCD 0x12345678
Y     DCD 0x87654321
      END
```



ARM Load and Store Encoding



To test this program, you need to change the permission of memory-locations from 0x30 to 0x33 (i.e., the location of Y) to make it read/write.

You also need to open a memory window to see the effect of the STR instructions.