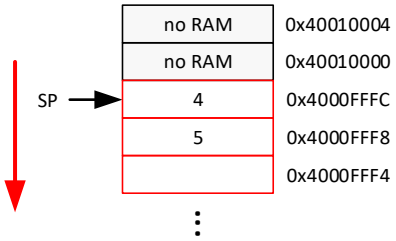
CS1021 Tutorial 8

Stacks and Subroutines

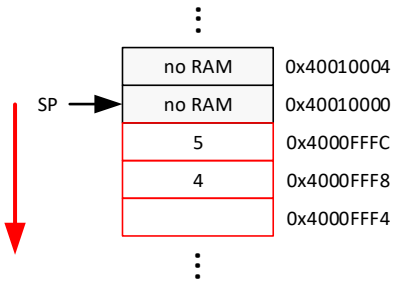
Q1 If SP = 0x40010000, R4 = 4, R5 =5 and R6 = 6 (1) draw a diagram of the stack after the following instructions are executed and (2) what are the contents of R4, R5, and R6?

(i)
```
PUSH  {R4}
PUSH  {R5}
POP   {R6}
```



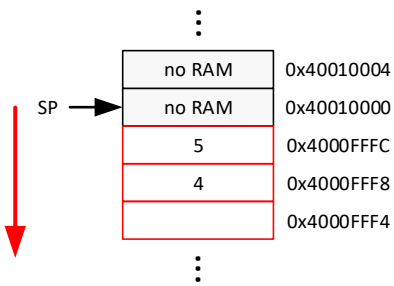
R4 = 4, R5 = 5, R6 = 5

(ii)
```
PUSH  {R4, R5}
POP   {R4, R5}
```



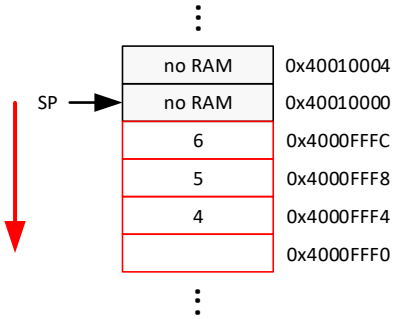
R4 = 4, R5 = 5, R6 = 6

(iii)
```
PUSH  {R4, R5}
POP   {R5, R4}
```



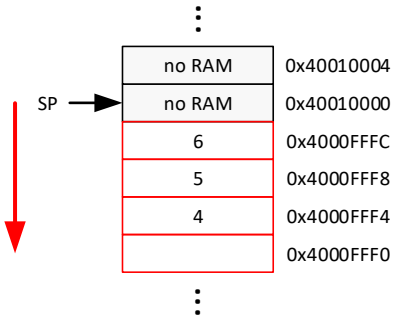
R4 = 4, R5 = 5, R6 = 6

(iv)
```
PUSH    {R4, R5, R6}
POP     {R6}
POP     {R5}
POP     {R4}
```



R4 = 6, R5 = 5, R6 = 4

(v)
```
PUSH    {R4, R5, R6}
POP     {R6, R4}
POP     {R5}
```



R4 = 4, R5 = 6, R6 = 5

Q2 If SP = 0x40010000 and R4 = 0, what do the following instructions do?

```
PUSH    {R4}            ; PC = 0 (branch to 0)
POP     {PC}
```

Q3 Write suitable entry and exit code for a leaf subroutine XXXX which modifies R4, R5, R6 and R7.

```
XXXX    PUSH    {R4, R5, R6, R7}    ; push R4, R5, R6 and R7
        …                           ;
        …                           ;
        POP     {R4, R5, R6, R7}    ; pop R4, R5, R6 and R7
        BX      LR                  ; return
```

Q4 Write suitable entry and exit code for a non-leaf subroutine YYYY which modifies R4, R5, and R7.

```
YYYY    PUSH    {R4, R5, R7, LR}    ; push R4, R5, R7 and return address
        …                           ;
        …                           ;
        POP     {R4, R5, R7, PC}    ; pop R4, R5, R7 and return
```

Q5 Write a subroutine STRLEN which returns the length of NUL terminated ASCII string in R0. The address of the string is passed to the subroutine in R0.

```
;
; leaf subroutine
;
STRLEN  MOV   R1, R0          ; R1-> str
        MOV   R0, #0          ; R0 = 0
STRLEN0 LDR   R2, [R1], #1    ; R2 = ch AND R1 = R1 + 1
        CMP   R2, #0          ; ch == 0?
        BEQ   STRLEN1         ; finished
        ADD   R0, R0, #1      ; R0 = R0 + 1
        B     STRLEN0         ; next ch
STRLEN1 BX    LR              ; return
```

Q6 Write a subroutine LEN that computes $\sqrt{x^2 + y^2}$. Assume x is passed to the subroutine in R0, y in R1 and that the result is returned in R0. Assume also that you can call a subroutine SQRT which the returns the integer square root of R0 in R0.

If a is stored @ 0x40000000, b @ 0x40000004 and c @ 0x40000008 respectively, write code, using subroutine LEN, to compute $c = \sqrt{a^2 + b^2}$.

```
;
; non-leaf subroutine (calls SQRT)
;
LEN     PUSH  {LR}            ; push return address
        MUL   R2, R0, R0      ; R2 = x*x
        MUL   R0, R1, R1      ; R0 = y*y
        ADD   R0, R2, R0      ; R0 = x*x + y*y
        BL    SQRT            ; R0 = sqrt(x*x + y*y)
        POP   {PC}            ; return

        ....

MAIN    LDR   R4, =0x40000000 ; R4 -> a (use R4 as it will not be modified by LEN)
        LDR   R0, [R4], #4    ; R0 = a AND R4 -> b
        LDR   R1, [R4], #4    ; R1 = b AND R4 -> c
        BL    LEN             ; R0 = sqrt(a*a + b*b)
        STR   R0, [R4]        ; c = sqrt(a*a + b*b)
```