

[숙제 5] lab1 실습 내용

제출할 자료:

실습 A : lab1 p33(factorial-recursive)에서 하나의 loop를 아래 설명처럼 line 단위로 실행시켜 레지스터, 메모리 값을 캡쳐한 후 값이 변하는 부분을 체크해서 첨부하세요.

facnum 초기값은 6이라고 하자. r0을 통해 어셈블리코드에 전달된다. P32 코드 5번 줄에 breakpoint를 설정한다. r0 = 2 가 될 때까지 go한다. r0=2일 때 5번줄부터 single instruction으로 한 line씩 수행하여 loop 코드 내 21번 line이 수행될 때까지 계속 추적한다 또한, 왜 그렇게 변하는지 assembly 명령어를 해석하여 설명하시오.

실습 B : 실습 A에서 8번, 9번 코드 수행 후 10번 코드 또는 14번 코드를 수행하게 되는데 어떤 상황에서 10번 코드를 수행하게 되는지 이유를 CPSR을 이용해 설명하시오.

화면캡쳐 및 설명내용을 준비한 뒤 하나의 압축file로 만들어 제출하세요.

실습 A : lab1 p33(factorial-recursive)에서 하나의 loop를 아래 설명처럼 line 단위로 실행시켜 레지스터, 메모리 값을 캡쳐한 후 값이 변하는 부분을 체크해서 첨부하세요.

memory		registers			
address	hex	name		value (hex)	value (decimal)
		r0	r1	0x2	2
more			r2	0x0	0
0xffffef050	58 01 01 00	r3	r4	0x89b20	564000
0xffffef054	00 00 00 00	0x89b28	68884		
0xffffef058	00 00 00 00	0x10d14			
0xffffef05c	04 9b 08 00	0x10158	65880		
loop:		r5	r6	0xb408	570376
0xffffef060	94 f0 fe ff	0x10158			
0xffffef064	24 6d 01 00	r7	r8	0x10158	65880
0xffffef068	03 00 00 00	0x89b04	4294897812		
0xffffef06c	68 05 01 00	r9	r10	0x89b04	563972
0xffffef070	04 00 00 00	0x89b04	4294897768		
0xffffef074	68 05 01 00	r11	r12	0x25	37
0xffffef078	05 00 00 00	sp	0x10568	66920	
0xffffef07c	68 05 01 00	lr	0x10568		
0xffffef080	06 00 00 00	pc	0x10564	66916	
0xffffef084	b0 05 01 00	cpsr			

<R0가 2로 바뀐 순간>

memory		registers			
address	hex	name		value (hex)	value (decimal)
		r0	r1	0x2	2
more			r2	0x0	0
0xffffef050	58 01 01 00	r3	r4	0x89b20	564000
0xffffef054	00 00 00 00	0x89b28	68884		
0xffffef058	00 00 00 00	0x10d14			
0xffffef05c	04 9b 08 00	0x10158	65880		
loop:		r5	r6	0xb408	570376
0xffffef060	94 f0 fe ff	0x10158			
0xffffef064	24 6d 01 00	r7	r8	0x10158	65880
0xffffef068	03 00 00 00	0x89b04	4294897812		
0xffffef06c	68 05 01 00	r9	r10	0x89b04	563972
0xffffef070	04 00 00 00	0x89b04	4294897768		
0xffffef074	68 05 01 00	r11	r12	0x25	37
0xffffef078	05 00 00 00	sp	0x10568	66920	
0xffffef07c	68 05 01 00	lr	0x10568		
0xffffef080	06 00 00 00	pc	0x10564	66916	
0xffffef084	b0 05 01 00	cpsr			

bl로 인해 분기하게 되어 pc가 변경되었다.

memory		registers			
address	hex	name		value (hex)	value (decimal)
		r0	r1	0x2	2
more			r2	0x0	0
0xffffef050	58 01 01 00	r3	r4	0x89b20	564000
0xffffef054	00 00 00 00	0x89b28	68884		
0xffffef058	00 00 00 00	0x10d14			
0xffffef05c	04 9b 08 00	0x10158	65880		
loop:		r5	r6	0xb408	570376
0xffffef060	94 f0 fe ff	0x10158			
0xffffef064	24 6d 01 00	r7	r8	0x10158	65880
0xffffef068	03 00 00 00	0x89b04	4294897812		
0xffffef06c	68 05 01 00	r9	r10	0x89b04	563972
0xffffef070	04 00 00 00	0x89b04	4294897760		
0xffffef074	68 05 01 00	r11	r12	0x25	37
0xffffef078	05 00 00 00	sp	0xffffef068	4294897760	
0xffffef07c	68 05 01 00	lr	0x10568	66920	
0xffffef080	06 00 00 00	pc	0x10544	66884	
0xffffef084	b0 05 01 00	cpsr			

sub에 의해 sp 가 sub연산으로 8 감소 되었다. pc가 변경되었다.

1	.text	memory			registers		
2	.global factRecursive	address	hex	name	value (hex)	value (decimal)	description
3	factRecursive:	0xffffef050	0xffffef097	r0	0x2	2	
4	sub sp, sp, #8	more		r1	0x0	0	
5	str lr, [sp, #4]	0xffffef050	58 01 01 00	r2	0x0	0	
6	str r0, [sp, #0]	0xffffef054	00 00 00 00	r3	0x89b20	564000	
7	cmp r0, #1	0xffffef058	00 00 00 00	r4	0x10d14	68884	
8	bge loop	0xffffef05c	04 9b 08 00	r5	0x10158	65880	
9	mov r0, #1	0xffffef060	94 f0 fe ff	r6	0x8b408	570376	
10	add sp, sp, #8	0xffffef064	68 05 01 00	r7	0x10158	65880	
11	mov pc, lr	0xffffef068	03 00 00 00	r8	0x0	0	register 8 (64-bit)
12	loop:	0xffffef06c	68 05 01 00	r9	0x0	0	register 9 (64-bit)
13	sub r0, r0, #1	0xffffef070	04 00 00 00	r10	0x89b04	563972	register 10 (64-bit)
14	bl factRecursive	0xffffef074	68 05 01 00	r11	0xffffef094	4294897812	register 11 (64-bit)
15	mov r12, r0	0xffffef078	05 00 00 00	r12	0x25	37	register 12 (64-bit)
16	ldr r0, [sp, #0]	0xffffef07c	68 05 01 00	sp	0xffffef060	4294897760	
17	ldr lr, [sp, #4]	0xffffef080	06 00 00 00	lr	0x10568	66920	
18	add sp, sp, #8	0xffffef084	b0 05 01 00	pc	0x10548	66892	
19	mul r0, r12, r0			cpsr			
20							
21							
22	.end						
23							
24	(end of file)						

str명령어로 인해 0xffffef064번 메모리에 lr값이 저장되었다. pc가 변경되었다.

1	.text <th data-cs="3" data-kind="parent">memory</th> <th data-kind="ghost"></th> <th data-kind="ghost"></th> <th data-cs="3" data-kind="parent">registers</th> <th data-kind="ghost"></th> <th data-kind="ghost"></th>	memory			registers		
2	.global factRecursive	address	hex	name	value (hex)	value (decimal)	description
3	factRecursive:	0xffffef050	0xffffef097	r0	0x2	2	
4	sub sp, sp, #8	more		r1	0x0	0	
5	str lr, [sp, #4]	0xffffef050	58 01 01 00	r2	0x0	0	
6	str r0, [sp, #0]	0xffffef054	00 00 00 00	r3	0x89b20	564000	
7	cmp r0, #1	0xffffef058	00 00 00 00	r4	0x10d14	68884	
8	bge loop	0xffffef05c	04 9b 08 00	r5	0x10158	65880	
9	mov r0, #1	0xffffef060	02 00 00 00	r6	0x8b408	570376	
10	add sp, sp, #8	0xffffef064	68 05 01 00	r7	0x10158	65880	
11	mov pc, lr	0xffffef068	03 00 00 00	r8	0x0	0	register 8 (64-bit)
12	loop:	0xffffef06c	68 05 01 00	r9	0x0	0	register 9 (64-bit)
13	sub r0, r0, #1	0xffffef070	04 00 00 00	r10	0x89b04	563972	register 10 (64-bit)
14	bl factRecursive	0xffffef074	68 05 01 00	r11	0xffffef094	4294897812	register 11 (64-bit)
15	mov r12, r0	0xffffef078	05 00 00 00	r12	0x25	37	register 12 (64-bit)
16	ldr r0, [sp, #0]	0xffffef07c	68 05 01 00	sp	0xffffef060	4294897760	
17	ldr lr, [sp, #4]	0xffffef080	06 00 00 00	lr	0x10568	66920	
18	add sp, sp, #8	0xffffef084	b0 05 01 00	pc	0x1054c	66892	
19	mul r0, r12, r0			cpsr			
20							
21							
22	.end						
23							
24	(end of file)						

str명령어로 인해 0xffffef060번 메모리에 2가 저장되었다. pc가 변경되었다.

1	.text <th data-cs="3" data-kind="parent">memory</th> <th data-kind="ghost"></th> <th data-kind="ghost"></th> <th data-cs="3" data-kind="parent">registers</th> <th data-kind="ghost"></th> <th data-kind="ghost"></th>	memory			registers		
2	.global factRecursive	address	hex	name	value (hex)	value (decimal)	description
3	factRecursive:	0xffffef050	0xffffef097	r0	0x2	2	
4	sub sp, sp, #8	more		r1	0x0	0	
5	str lr, [sp, #4]	0xffffef050	58 01 01 00	r2	0x0	0	
6	str r0, [sp, #0]	0xffffef054	00 00 00 00	r3	0x89b20	564000	
7	cmp r0, #1	0xffffef058	00 00 00 00	r4	0x10d14	68884	
8	bge loop	0xffffef05c	04 9b 08 00	r5	0x10158	65880	
9	mov r0, #1	0xffffef060	02 00 00 00	r6	0x8b408	570376	
10	add sp, sp, #8	0xffffef064	68 05 01 00	r7	0x10158	65880	
11	mov pc, lr	0xffffef068	03 00 00 00	r8	0x0	0	register 8 (64-bit)
12	loop:	0xffffef06c	68 05 01 00	r9	0x0	0	register 9 (64-bit)
13	sub r0, r0, #1	0xffffef070	04 00 00 00	r10	0x89b04	563972	register 10 (64-bit)
14	bl factRecursive	0xffffef074	68 05 01 00	r11	0xffffef094	4294897812	register 11 (64-bit)
15	mov r12, r0	0xffffef078	05 00 00 00	r12	0x25	37	register 12 (64-bit)
16	ldr r0, [sp, #0]	0xffffef07c	68 05 01 00	sp	0xffffef060	4294897760	
17	ldr lr, [sp, #4]	0xffffef080	06 00 00 00	lr	0x10568	66920	
18	add sp, sp, #8	0xffffef084	b0 05 01 00	pc	0x10550	66896	
19	mul r0, r12, r0			cpsr			
20							
21							
22	.end						
23							
24	(end of file)						

cmp 명령어로 cpsr값이 변경되었지만 표시되지 않는다. pc가 변경되었다.

Registers			
name	value (hex)	value (decimal)	description
r0	0x2	2	
r1	0x0	0	
r2	0x0	0	
r3	0x89b20	564000	
r4	0x10d14	68884	
r5	0x10158	65880	
r6	0x8b408	570376	
r7	0x10158	65880	
r8	0x0	0	register 8 (64-bit)
r9	0x0	0	register 9 (64-bit)
r10	0x89b04	563972	register 10 (64-bit)
r11	0xffffef094	4294897812	register 11 (64-bit)
r12	0x25	37	register 12 (64-bit)
sp	0xffffef060	4294897760	
lr	0x10568	66920	
pc	0x10560	66912	

bge로 pc가 변경되었다.

Registers			
name	value (hex)	value (decimal)	description
r0	0x1	1	
r1	0x0	0	
r2	0x0	0	
r3	0x89b20	564000	
r4	0x10d14	68884	
r5	0x10158	65880	
r6	0x8b408	570376	
r7	0x10158	65880	
r8	0x0	0	register 8 (64-bit)
r9	0x0	0	register 9 (64-bit)
r10	0x89b04	563972	register 10 (64-bit)
r11	0xffffef094	4294897812	register 11 (64-bit)
r12	0x25	37	register 12 (64-bit)
sp	0xffffef060	4294897760	
lr	0x10568	66920	
pc	0x10564	66916	

sub로 인해 r0가 1감소했다. pc가 변경되었다.

Registers			
name	value (hex)	value (decimal)	description
r0	0x1	1	
r1	0x0	0	
r2	0x0	0	
r3	0x89b20	564000	
r4	0x10d14	68884	
r5	0x10158	65880	
r6	0x8b408	570376	
r7	0x10158	65880	
r8	0x0	0	register 8 (64-bit)
r9	0x0	0	register 9 (64-bit)
r10	0x89b04	563972	register 10 (64-bit)
r11	0xffffef094	4294897812	register 11 (64-bit)
r12	0x25	37	register 12 (64-bit)
sp	0xffffef060	4294897760	
lr	0x10568	66920	
pc	0x10540	66880	

b로 pc가 변경되었다.

Registers			
address	hex	name	value (hex) (decimal)
0xffffef050	58 01 01 00	r0	0x1 1
0xffffef051	00 00 00 00	r1	0x0 0
0xffffef052	00 00 00 00	r2	0x0 0
0xffffef053	00 00 00 00	r3	0x89b20 564000
0xffffef054	00 00 00 00	r4	0x10d14 68884
0xffffef055	04 9b 08 00	r5	0x10158 65880
0xffffef056	02 00 00 00	r6	0x8b408 570376
0xffffef057	68 05 01 00	r7	0x10158 65880
0xffffef058	03 00 00 00	r8	0x0 0
0xffffef059	68 05 01 00	r9	0x0 0
0xffffef060	04 00 00 00	r10	0x89b04 563972
0xffffef061	68 05 01 00	r11	0xffffef094 4294897812
0xffffef062	05 00 00 00	r12	0x25 37
0xffffef063	68 05 01 00	sp	0xffffef058 4294897752
0xffffef064	06 00 00 00	lr	0x10568 66920
0xffffef065	b0 05 01 00	pc	0x10544 66884

sp 가 sub연산으로 8 감소 되었다. pc가 변경되었다.

Registers			
address	hex	name	value (hex) (decimal)
0xffffef050	58 01 01 00	r0	0x1 1
0xffffef051	00 00 00 00	r1	0x0 0
0xffffef052	00 00 00 00	r2	0x0 0
0xffffef053	00 00 00 00	r3	0x89b20 564000
0xffffef054	00 00 00 00	r4	0x10d14 68884
0xffffef055	68 05 01 00	r5	0x10158 65880
0xffffef056	02 00 00 00	r6	0x8b408 570376
0xffffef057	68 05 01 00	r7	0x10158 65880
0xffffef058	03 00 00 00	r8	0x0 0
0xffffef059	68 05 01 00	r9	0x0 0
0xffffef060	04 00 00 00	r10	0x89b04 563972
0xffffef061	68 05 01 00	r11	0xffffef094 4294897812
0xffffef062	05 00 00 00	r12	0x25 37
0xffffef063	68 05 01 00	sp	0xffffef058 4294897752
0xffffef064	06 00 00 00	lr	0x10568 66920
0xffffef065	b0 05 01 00	pc	0x10548 66884

str명령어로 인해 0xffffef05c번 메모리에 lr값이 저장되었다. pc가 변경되었다.

Registers			
address	hex	name	value (hex) (decimal)
0xffffef050	58 01 01 00	r0	0x1 1
0xffffef051	00 00 00 00	r1	0x0 0
0xffffef052	00 00 00 00	r2	0x0 0
0xffffef053	00 00 00 00	r3	0x89b20 564000
0xffffef054	01 00 00 00	r4	0x10d14 68884
0xffffef055	68 05 01 00	r5	0x10158 65880
0xffffef056	02 00 00 00	r6	0x8b408 570376
0xffffef057	68 05 01 00	r7	0x10158 65880
0xffffef058	03 00 00 00	r8	0x0 0
0xffffef059	68 05 01 00	r9	0x0 0
0xffffef060	04 00 00 00	r10	0x89b04 563972
0xffffef061	68 05 01 00	r11	0xffffef094 4294897812
0xffffef062	05 00 00 00	r12	0x25 37
0xffffef063	68 05 01 00	sp	0xffffef058 4294897752
0xffffef064	06 00 00 00	lr	0x10568 66920
0xffffef065	b0 05 01 00	pc	0x1054c 66892

str명령어로 인해 0xffffef058번 메모리에 1이 저장되었다. pc가 변경되었다.

memory				registers		
address	hex	name	value (hex)	value (decimal)	description	
0xffffef050	0xffffef097	more	r0	0x1	1	
0xffffef050	58 01 01 00	r1	0x0	0		
0xffffef054	00 00 00 00	r2	0x0	0		
0xffffef058	01 00 00 00	r3	0x89b20	564000		
0xffffef05c	68 05 01 00	r4	0x10d14	68884		
0xffffef060	02 00 00 00	r5	0x10158	65880		
0xffffef064	68 05 01 00	r6	0x8b408	570376		
0xffffef068	03 00 00 00	r7	0x10158	65880		
0xffffef06c	68 05 01 00	r8	0x0	0	register 8 (64-bit)	
0xffffef070	04 00 00 00	r9	0x0	0	register 9 (64-bit)	
0xffffef074	68 05 01 00	r10	0x89b04	563972	register 10 (64-bit)	
0xffffef078	05 00 00 00	r11	0xffffef094	4294897812	register 11 (64-bit)	
0xffffef07c	68 05 01 00	r12	0x25	37	register 12 (64-bit)	
0xffffef080	06 00 00 00	sp	0xffffef058	4294897752		
0xffffef084	b0 05 01 00	lr	0x10568	66920		
0xffffef084	b0 05 01 00	pc	0x10550	66896		

cmp 명령어로 cpsr값이 변경되었지만 표시되지 않는다. pc가 변경되었다.

memory				registers		
address	hex	name	value (hex)	value (decimal)	description	
0xffffef050	0xffffef097	more	r0	0x1	1	
0xffffef050	58 01 01 00	r1	0x0	0		
0xffffef054	00 00 00 00	r2	0x0	0		
0xffffef058	01 00 00 00	r3	0x89b20	564000		
0xffffef05c	68 05 01 00	r4	0x10d14	68884		
0xffffef060	02 00 00 00	r5	0x10158	65880		
0xffffef064	68 05 01 00	r6	0x8b408	570376		
0xffffef068	03 00 00 00	r7	0x10158	65880		
0xffffef06c	68 05 01 00	r8	0x0	0	register 8 (64-bit)	
0xffffef070	04 00 00 00	r9	0x0	0	register 9 (64-bit)	
0xffffef074	68 05 01 00	r10	0x89b04	563972	register 10 (64-bit)	
0xffffef078	05 00 00 00	r11	0xffffef094	4294897812	register 11 (64-bit)	
0xffffef07c	68 05 01 00	r12	0x25	37	register 12 (64-bit)	
0xffffef080	06 00 00 00	sp	0xffffef058	4294897752		
0xffffef084	68 05 01 00	lr	0x10568	66920		
0xffffef084	b0 05 01 00	pc	0x10560	66912		
0xffffef084	b0 05 01 00	cpsr				

bge로 pc가 변경되었다.

memory				registers		
address	hex	name	value (hex)	value (decimal)	description	
0xffffef050	0xffffef097	more	r0	0x0	0	
0xffffef050	58 01 01 00	r1	0x0	0		
0xffffef054	00 00 00 00	r2	0x0	0		
0xffffef058	01 00 00 00	r3	0x89b20	564000		
0xffffef05c	68 05 01 00	r4	0x10d14	68884		
0xffffef060	02 00 00 00	r5	0x10158	65880		
0xffffef064	68 05 01 00	r6	0x8b408	570376		
0xffffef068	03 00 00 00	r7	0x10158	65880		
0xffffef06c	68 05 01 00	r8	0x0	0	register 8 (64-bit)	
0xffffef070	04 00 00 00	r9	0x0	0	register 9 (64-bit)	
0xffffef074	68 05 01 00	r10	0x89b04	563972	register 10 (64-bit)	
0xffffef078	05 00 00 00	r11	0xffffef094	4294897812	register 11 (64-bit)	
0xffffef07c	68 05 01 00	r12	0x25	37	register 12 (64-bit)	
0xffffef080	06 00 00 00	sp	0xffffef058	4294897752		
0xffffef084	68 05 01 00	lr	0x10568	66920		
0xffffef084	b0 05 01 00	pc	0x10564	66916		
0xffffef084	b0 05 01 00	cpsr				

sub 연산으로 r0가 1감소하였다. pc가 변경되었다.

```

1 .text
2 .global factRecursive
3
4 factRecursive:
5   sub sp, sp, #8
6   str lr, [sp, #4]
7   str r0, [sp, #0]
8   cmp r0, #1
9   bge loop
10  mov r0, #1
11  add sp, sp, #8
12  mov pc, lr
13 loop:
14  sub r0, r0, #1
15  bl factRecursive
16  mov r12, r0
17  ldr r0, [sp, #0]
18  ldr lr, [sp, #4]
19  add sp, sp, #8
20  mul r0, r12, r0
21  mov pc, lr
22 .end
23
24 (end of file)

```

Registers					
Memory			Name	Value (hex)	Value (decimal)
0xffffef050	0xffffef097	4	r0	0x0	0
more			r1	0x0	0
0xffffef050	58 01 01 00		r2	0x0	0
0xffffef054	00 00 00 00		r3	0x89b20	564000
0xffffef058	01 00 00 00		r4	0x10d14	68884
0xffffef05c	68 05 01 00		r5	0x10158	65880
0xffffef060	02 00 00 00		r6	0x8b408	570376
0xffffef064	68 05 01 00		r7	0x10158	65880
0xffffef068	03 00 00 00		r8	0x0	0
0xffffef06c	68 05 01 00		r9	0x0	0
0xffffef070	04 00 00 00		r10	0x89b04	563972
0xffffef074	68 05 01 00		r11	0xffffef094	4294897812
0xffffef078	05 00 00 00		r12	0x25	37
0xffffef07c	68 05 01 00		sp	0xffffef058	4294897752
0xffffef080	06 00 00 00		lr	0x10568	66920
0xffffef084	b0 05 01 00		pc	0x10540	66880

bl로 pc가 변경되었다.

```

1 .text
2 .global factRecursive
3
4 factRecursive:
5   sub sp, sp, #8
6   str lr, [sp, #4]
7   str r0, [sp, #0]
8   cmp r0, #1
9   bge loop
10  mov r0, #1
11  add sp, sp, #8
12  mov pc, lr
13 loop:
14  sub r0, r0, #1
15  bl factRecursive
16  mov r12, r0
17  ldr r0, [sp, #0]
18  ldr lr, [sp, #4]
19  add sp, sp, #8
20  mul r0, r12, r0
21  mov pc, lr
22 .end
23
24 (end of file)

```

Registers					
Memory			Name	Value (hex)	Value (decimal)
0xffffef050	0xffffef097	4	r0	0x0	0
more			r1	0x0	0
0xffffef050	58 01 01 00		r2	0x0	0
0xffffef054	00 00 00 00		r3	0x89b20	564000
0xffffef058	01 00 00 00		r4	0x10d14	68884
0xffffef05c	68 05 01 00		r5	0x10158	65880
0xffffef060	02 00 00 00		r6	0x8b408	570376
0xffffef064	68 05 01 00		r7	0x10158	65880
0xffffef068	03 00 00 00		r8	0x0	0
0xffffef06c	68 05 01 00		r9	0x0	0
0xffffef070	04 00 00 00		r10	0x89b04	563972
0xffffef074	68 05 01 00		r11	0xffffef094	4294897812
0xffffef078	05 00 00 00		r12	0x25	37
0xffffef07c	68 05 01 00		sp	0xffffef050	4294897744
0xffffef080	06 00 00 00		lr	0x10568	66920
0xffffef084	b0 05 01 00		pc	0x10544	66884

sub명령어로 sp값이 8감소하였다. pc가 변경되었다.

```

1 .text
2 .global factRecursive
3
4 factRecursive:
5   sub sp, sp, #8
6   str lr, [sp, #4]
7   str r0, [sp, #0]
8   cmp r0, #1
9   bge loop
10  mov r0, #1
11  add sp, sp, #8
12  mov pc, lr
13 loop:
14  sub r0, r0, #1
15  bl factRecursive
16  mov r12, r0
17  ldr r0, [sp, #0]
18  ldr lr, [sp, #4]
19  add sp, sp, #8
20  mul r0, r12, r0
21  mov pc, lr
22 .end
23
24 (end of file)

```

Registers					
Memory			Name	Value (hex)	Value (decimal)
0xffffef050	0xffffef097	4	r0	0x0	0
more			r1	0x0	0
0xffffef050	58 01 01 00		r2	0x0	0
0xffffef054	68 05 01 00		r3	0x89b20	564000
0xffffef058	01 00 00 00		r4	0x10d14	68884
0xffffef05c	68 05 01 00		r5	0x10158	65880
0xffffef060	02 00 00 00		r6	0x8b408	570376
0xffffef064	68 05 01 00		r7	0x10158	65880
0xffffef068	03 00 00 00		r8	0x0	0
0xffffef06c	68 05 01 00		r9	0x0	0
0xffffef070	04 00 00 00		r10	0x89b04	563972
0xffffef074	68 05 01 00		r11	0xffffef094	4294897812
0xffffef078	05 00 00 00		r12	0x25	37
0xffffef07c	68 05 01 00		sp	0xffffef050	4294897744
0xffffef080	06 00 00 00		lr	0x10568	66920
0xffffef084	b0 05 01 00		pc	0x10548	66888

str명령어로 인해 0xffffef054번 메모리에 lr이 저장되었다. pc가 변경되었다.

memory				registers		
address	hex	name	value (hex)	value (decimal)	description	
more		r0	0x0	0		
0xffffef050	00 00 00 00	r1	0x0	0		
		r2	0x0	0		
0xffffef054	68 05 01 00	r3	0x89b20	564000		
0xffffef058	01 00 00 00	r4	0x10d14	68884		
0xffffef05c	68 05 01 00	r5	0x10158	65880		
0xffffef060	02 00 00 00	r6	0x8b408	570376		
0xffffef064	68 05 01 00	r7	0x10158	65880		
0xffffef068	03 00 00 00	r8	0x0	0	register 8 (64-bit)	
0xffffef06c	68 05 01 00	r9	0x0	0	register 9 (64-bit)	
0xffffef070	04 00 00 00	r10	0x89b04	563972	register 10 (64-bit)	
0xffffef074	68 05 01 00	r11	0xffffef094	4294897812	register 11 (64-bit)	
0xffffef078	05 00 00 00	r12	0x25	37	register 12 (64-bit)	
0xffffef07c	68 05 01 00	sp	0xffffef050	4294897744		
0xffffef080	06 00 00 00	lr	0x10568	66920		
0xffffef084	b0 05 01 00	pc	0x1054c	66892		

str 명령어로 인해 0xffffef058번 메모리에 0이 저장되었다. pc가 변경되었다.

memory				registers		
address	hex	name	value (hex)	value (decimal)	description	
more		r0	0x0	0		
0xffffef050	00 00 00 00	r1	0x0	0		
		r2	0x0	0		
0xffffef054	68 05 01 00	r3	0x89b20	564000		
0xffffef058	01 00 00 00	r4	0x10d14	68884		
0xffffef05c	68 05 01 00	r5	0x10158	65880		
0xffffef060	02 00 00 00	r6	0x8b408	570376		
0xffffef064	68 05 01 00	r7	0x10158	65880		
0xffffef068	03 00 00 00	r8	0x0	0	register 8 (64-bit)	
0xffffef06c	68 05 01 00	r9	0x0	0	register 9 (64-bit)	
0xffffef070	04 00 00 00	r10	0x89b04	563972	register 10 (64-bit)	
0xffffef074	68 05 01 00	r11	0xffffef094	4294897812	register 11 (64-bit)	
0xffffef078	05 00 00 00	r12	0x25	37	register 12 (64-bit)	
0xffffef07c	68 05 01 00	sp	0xffffef050	4294897744		
0xffffef080	06 00 00 00	lr	0x10568	66920		
0xffffef084	b0 05 01 00	pc	0x10550	66896		

cmp 명령어로 cpsr 값이 변경되었지만 표시되지 않는다. pc가 변경되었다.

memory				registers		
address	hex	name	value (hex)	value (decimal)	description	
more		r0	0x0	0		
0xffffef050	00 00 00 00	r1	0x0	0		
		r2	0x0	0		
0xffffef054	68 05 01 00	r3	0x89b20	564000		
0xffffef058	01 00 00 00	r4	0x10d14	68884		
0xffffef05c	68 05 01 00	r5	0x10158	65880		
0xffffef060	02 00 00 00	r6	0x8b408	570376		
0xffffef064	68 05 01 00	r7	0x10158	65880		
0xffffef068	03 00 00 00	r8	0x0	0	register 8 (64-bit)	
0xffffef06c	68 05 01 00	r9	0x0	0	register 9 (64-bit)	
0xffffef070	04 00 00 00	r10	0x89b04	563972	register 10 (64-bit)	
0xffffef074	68 05 01 00	r11	0xffffef094	4294897812	register 11 (64-bit)	
0xffffef078	05 00 00 00	r12	0x25	37	register 12 (64-bit)	
0xffffef07c	68 05 01 00	sp	0xffffef050	4294897744		
0xffffef080	06 00 00 00	lr	0x10568	66920		
0xffffef084	b0 05 01 00	pc	0x10554	66900		

branch 조건에 맞지 않아 다음 명령어로 이동한다.

Registers			
address	hex	name	value (hex) value (decimal) description
0xffffef050	0x00000000	r0	0x1 1
0xffffef050	0x00000000	r1	0x0 0
0xffffef054	0x00000100	r2	0x0 0
0xffffef058	0x00000000	r3	0x89b20 564000
0xffffef05c	0x00000100	r4	0x10d14 68884
0xffffef060	0x00000000	r5	0x10158 65880
0xffffef064	0x00000100	r6	0x8b408 570376
0xffffef068	0x00000000	r7	0x10158 65880
0xffffef06c	0x00000100	r8	0x0 0 register 8 (64-bit)
0xffffef070	0x00000000	r9	0x0 0 register 9 (64-bit)
0xffffef074	0x00000100	r10	0x89b04 563972 register 10 (64-bit)
0xffffef078	0x00000000	r11	0xffffef094 4294897812 register 11 (64-bit)
0xffffef07c	0x00000100	sp	0xffffef050 4294897744
0xffffef080	0x00000000	lr	0x10568 66920
0xffffef084	0x00000100	pc	0x10558 66904

mov에 의해 r0 값이 1로 변경되었다. pc가 변경되었다.

Registers			
address	hex	name	value (hex) value (decimal) description
0xffffef050	0x00000000	r0	0x1 1
0xffffef050	0x00000000	r1	0x0 0
0xffffef054	0x00000100	r2	0x0 0
0xffffef058	0x00000000	r3	0x89b20 564000
0xffffef05c	0x00000100	r4	0x10d14 68884
0xffffef060	0x00000000	r5	0x10158 65880
0xffffef064	0x00000100	r6	0x8b408 570376
0xffffef068	0x00000000	r7	0x10158 65880
0xffffef06c	0x00000100	r8	0x0 0 register 8 (64-bit)
0xffffef070	0x00000000	r9	0x0 0 register 9 (64-bit)
0xffffef074	0x00000100	r10	0x89b04 563972 register 10 (64-bit)
0xffffef078	0x00000000	r11	0xffffef094 4294897812 register 11 (64-bit)
0xffffef07c	0x00000100	sp	0xffffef058 4294897752
0xffffef080	0x00000000	lr	0x10568 66920
0xffffef084	0x00000100	pc	0x1055c 66908

add에 의해 sp가 증가했다. pc가 변경되었다.

Registers			
address	hex	name	value (hex) value (decimal) description
0xffffef050	0x00000000	r0	0x1 1
0xffffef050	0x00000000	r1	0x0 0
0xffffef054	0x00000100	r2	0x0 0
0xffffef058	0x00000000	r3	0x89b20 564000
0xffffef05c	0x00000100	r4	0x10d14 68884
0xffffef060	0x00000000	r5	0x10158 65880
0xffffef064	0x00000100	r6	0x8b408 570376
0xffffef068	0x00000000	r7	0x10158 65880
0xffffef06c	0x00000100	r8	0x0 0 register 8 (64-bit)
0xffffef070	0x00000000	r9	0x0 0 register 9 (64-bit)
0xffffef074	0x00000100	r10	0x89b04 563972 register 10 (64-bit)
0xffffef078	0x00000000	r11	0xffffef094 4294897812 register 11 (64-bit)
0xffffef07c	0x00000100	sp	0xffffef058 4294897752
0xffffef080	0x00000000	lr	0x10568 66920
0xffffef084	0x00000100	pc	0x1055c 66908

mov에 의해 pc가 lr에 저장된 값으로 변경된다.

Registers			
address	hex	name	value (hex) value (decimal)
0xffffef050	0xffffef097	r0	0x1 1
more		r1	0x0 0
0xffffef050	00 00 00 00	r2	0x0 0
0xffffef054	68 05 01 00	r3	0x89b20 564000
0xffffef058	01 00 00 00	r4	0x10d14 68884
0xffffef05c	68 05 01 00	r5	0x10158 65880
0xffffef060	02 00 00 00	r6	0x8b408 570376
0xffffef064	68 05 01 00	r7	0x10158 65880
0xffffef068	03 00 00 00	r8	0x0 0 register 8 (64-bit)
0xffffef06c	68 05 01 00	r9	0x0 0 register 9 (64-bit)
0xffffef070	04 00 00 00	r10	0x89b04 563972 register 10 (64-bit)
0xffffef074	68 05 01 00	r11	0xffffef094 4294897812 register 11 (64-bit)
0xffffef078	05 00 00 00	r12	0x1 1 register 12 (64-bit)
0xffffef07c	68 05 01 00	sp	0xffffef058 4294897752
0xffffef080	06 00 00 00	lr	0x10568 66920
0xffffef084	b0 05 01 00	pc	0x1056c 66924
		cpsr	

mov에 의해 r12에 r0의 값을 저장한다. pc가 변경된다.

Registers			
address	hex	name	value (hex) value (decimal)
0xffffef050	0xffffef097	r0	0x1 1
more		r1	0x0 0
0xffffef050	00 00 00 00	r2	0x0 0
0xffffef054	68 05 01 00	r3	0x89b20 564000
0xffffef058	01 00 00 00	r4	0x10d14 68884
0xffffef05c	68 05 01 00	r5	0x10158 65880
0xffffef060	02 00 00 00	r6	0x8b408 570376
0xffffef064	68 05 01 00	r7	0x10158 65880
0xffffef068	03 00 00 00	r8	0x0 0 register 8 (64-bit)
0xffffef06c	68 05 01 00	r9	0x0 0 register 9 (64-bit)
0xffffef070	04 00 00 00	r10	0x89b04 563972 register 10 (64-bit)
0xffffef074	68 05 01 00	r11	0xffffef094 4294897812 register 11 (64-bit)
0xffffef078	05 00 00 00	r12	0x1 1 register 12 (64-bit)
0xffffef07c	68 05 01 00	sp	0xffffef058 4294897752
0xffffef080	06 00 00 00	lr	0x10568 66920
0xffffef084	b0 05 01 00	pc	0x10570 66928

ldr를 통해 r0에 stack의 가장 위의 값이 저장된다. pc가 변경된다.

Registers			
address	hex	name	value (hex) value (decimal)
0xffffef050	0xffffef097	r0	0x1 1
more		r1	0x0 0
0xffffef050	00 00 00 00	r2	0x0 0
0xffffef054	68 05 01 00	r3	0x89b20 564000
0xffffef058	01 00 00 00	r4	0x10d14 68884
0xffffef05c	68 05 01 00	r5	0x10158 65880
0xffffef060	02 00 00 00	r6	0x8b408 570376
0xffffef064	68 05 01 00	r7	0x10158 65880
0xffffef068	03 00 00 00	r8	0x0 0 register 8 (64-bit)
0xffffef06c	68 05 01 00	r9	0x0 0 register 9 (64-bit)
0xffffef070	04 00 00 00	r10	0x89b04 563972 register 10 (64-bit)
0xffffef074	68 05 01 00	r11	0xffffef094 4294897812 register 11 (64-bit)
0xffffef078	05 00 00 00	sp	0xffffef058 4294897752
0xffffef07c	68 05 01 00	lr	0x10568 66920
0xffffef080	06 00 00 00	pc	0x10574 66932
		cpsr	

ldr에 의해 lr에 stack에서 pop한 lr이 저장된다. pc값 변경된다.

Registers			
address	hex	name	value (hex) (decimal)
0xffffef050	0xffffef097	r0	0x1 1
more		r1	0x0 0
0xffffef050	00 00 00 00	r2	0x0 0
0xffffef054	68 05 01 00	r3	0x89b20 564000
0xffffef058	01 00 00 00	r4	0x10d14 68884
0xffffef05c	68 05 01 00	r5	0x10158 65880
0xffffef060	02 00 00 00	r6	0x8b408 570376
0xffffef064	68 05 01 00	r7	0x10158 65880
0xffffef068	03 00 00 00	r8	0x0 0
0xffffef06c	68 05 01 00	r9	0x0 0
0xffffef070	04 00 00 00	r10	0x89b04 563972
0xffffef074	68 05 01 00	r11	0xffffef094 4294897812
0xffffef078	05 00 00 00	r12	0x1 1
0xffffef07c	68 05 01 00	sp	0xffffef060 4294897760
0xffffef080	06 00 00 00	lr	0x10568 66920
0xffffef084	b0 05 01 00	pc	0x10578 66936
0xffffef084	b0 05 01 00	cpsr	

add에 의해 sp가 8만큼 증가한다. pc가 변경되었다.

Registers			
address	hex	name	value (hex) (decimal)
0xffffef050	0xffffef097	r0	0x1 1
more		r1	0x0 0
0xffffef050	00 00 00 00	r2	0x0 0
0xffffef054	68 05 01 00	r3	0x89b20 564000
0xffffef058	01 00 00 00	r4	0x10d14 68884
0xffffef05c	68 05 01 00	r5	0x10158 65880
0xffffef060	02 00 00 00	r6	0x8b408 570376
0xffffef064	68 05 01 00	r7	0x10158 65880
0xffffef068	03 00 00 00	r8	0x0 0
0xffffef06c	68 05 01 00	r9	0x0 0
0xffffef070	04 00 00 00	r10	0x89b04 563972
0xffffef074	68 05 01 00	r11	0xffffef094 4294897812
0xffffef078	05 00 00 00	r12	0x1 1
0xffffef07c	68 05 01 00	sp	0xffffef060 4294897760
0xffffef080	06 00 00 00	lr	0x10568 66920
0xffffef084	b0 05 01 00	pc	0x1057c 66940
0xffffef084	b0 05 01 00	cpsr	

mov에 의해 r0에 r0*r12가 저장된다. pc가 변경된다.

Registers			
address	hex	name	value (hex) (decimal)
0xffffef050	0xffffef097	r0	0x1 1
more		r1	0x0 0
0xffffef050	00 00 00 00	r2	0x0 0
0xffffef054	68 05 01 00	r3	0x89b20 564000
0xffffef058	01 00 00 00	r4	0x10d14 68884
0xffffef05c	68 05 01 00	r5	0x10158 65880
0xffffef060	02 00 00 00	r6	0x8b408 570376
0xffffef064	68 05 01 00	r7	0x10158 65880
0xffffef068	03 00 00 00	r8	0x0 0
0xffffef06c	68 05 01 00	r9	0x0 0
0xffffef070	04 00 00 00	r10	0x89b04 563972
0xffffef074	68 05 01 00	r11	0xffffef094 4294897812
0xffffef078	05 00 00 00	r12	0x1 1
0xffffef07c	68 05 01 00	sp	0xffffef060 4294897760
0xffffef080	06 00 00 00	lr	0x10568 66920
0xffffef084	b0 05 01 00	pc	0x10568 66920

mov에 의해 pc가 lr에 저장된 값으로 변경된다.

Registers			
name	value (hex)	value (decimal)	description
r0	0x1	1	
r1	0x0	0	
r2	0x0	0	
r3	0x89b20	564000	
r4	0x10d14	68884	
r5	0x10158	65880	
r6	0x8b408	570376	
r7	0x10158	65880	
r8	0x0	0	register 8 (64-bit)
r9	0x0	0	register 9 (64-bit)
r10	0x89b04	563972	register 10 (64-bit)
r11	0xffffef094	4294897812	register 11 (64-bit)
r12	0x1	1	register 12 (64-bit)
sp	0xffffef060	4294897760	
lr	0x10568	66920	
pc	0x1056c	66924	
cpsr			

mov에 의해 r12에 r0값을 저장한다. pc가 변경된다.

Registers			
name	value (hex)	value (decimal)	description
r0	0x2	2	
r1	0x0	0	
r2	0x0	0	
r3	0x89b20	564000	
r4	0x10d14	68884	
r5	0x10158	65880	
r6	0x8b408	570376	
r7	0x10158	65880	
r8	0x0	0	register 8 (64-bit)
r9	0x0	0	register 9 (64-bit)
r10	0x89b04	563972	register 10 (64-bit)
r11	0xffffef094	4294897812	register 11 (64-bit)
r12	0x1	1	register 12 (64-bit)
sp	0xffffef060	4294897760	
lr	0x10568	66920	
pc	0x10570	66928	
cpsr			

ldr에 의해 r0에 stack최상단 값을 불러와 저장한다. pc가 변경된다.

Registers			
name	value (hex)	value (decimal)	description
r0	0x2	2	
r1	0x0	0	
r2	0x0	0	
r3	0x89b20	564000	
r4	0x10d14	68884	
r5	0x10158	65880	
r6	0x8b408	570376	
r7	0x10158	65880	
r8	0x0	0	register 8 (64-bit)
r9	0x0	0	register 9 (64-bit)
r10	0x89b04	563972	register 10 (64-bit)
r11	0xffffef094	4294897812	register 11 (64-bit)
r12	0x1	1	register 12 (64-bit)
sp	0xffffef060	4294897760	
lr	0x10568	66920	
pc	0x10574	66932	
cpsr			

ldr에 의해 lr에 stack에서 pop한 lr값을 저장한다. pc가 변경된다.

Registers			
address	hex	name	value (hex) value (decimal) description
0xffffef050	0xffffef097	r0	0x2 2
more		r1	0x0 0
0xffffef050	00 00 00 00	r2	0x0 0
0xffffef054	68 05 01 00	r3	0x89b20 564000
0xffffef058	01 00 00 00	r4	0x10d14 68884
0xffffef05c	68 05 01 00	r5	0x10158 65880
0xffffef060	02 00 00 00	r6	0x8b408 570376
0xffffef064	68 05 01 00	r7	0x10158 65880
0xffffef068	03 00 00 00	r8	0x0 0 register 8 (64-bit)
0xffffef06c	68 05 01 00	r9	0x0 0 register 9 (64-bit)
0xffffef070	04 00 00 00	r10	0x89b04 563972 register 10 (64-bit)
0xffffef074	68 05 01 00	r11	0xffffef094 4294897812 register 11 (64-bit)
0xffffef078	05 00 00 00	r12	0x1 1 register 12 (64-bit)
0xffffef07c	68 05 01 00	sp	0xffffef068 4294897768
0xffffef080	06 00 00 00	lr	0x10568 66920
0xffffef084	b0 05 01 00	pc	0x10578 66936
0xffffef084	b0 05 01 00	cpsr	

add에 의해 sp값에 8을 더한다. pc가 변경된다.

Registers			
address	hex	name	value (hex) value (decimal) description
0xffffef050	0xffffef097	r0	0x2 2
more		r1	0x0 0
0xffffef050	00 00 00 00	r2	0x0 0
0xffffef054	68 05 01 00	r3	0x89b20 564000
0xffffef058	01 00 00 00	r4	0x10d14 68884
0xffffef05c	68 05 01 00	r5	0x10158 65880
0xffffef060	02 00 00 00	r6	0x8b408 570376
0xffffef064	68 05 01 00	r7	0x10158 65880
0xffffef068	03 00 00 00	r8	0x0 0 register 8 (64-bit)
0xffffef06c	68 05 01 00	r9	0x0 0 register 9 (64-bit)
0xffffef070	04 00 00 00	r10	0x89b04 563972 register 10 (64-bit)
0xffffef074	68 05 01 00	r11	0xffffef094 4294897812 register 11 (64-bit)
0xffffef078	05 00 00 00	r12	0x1 1 register 12 (64-bit)
0xffffef07c	68 05 01 00	sp	0xffffef068 4294897768
0xffffef080	06 00 00 00	lr	0x10568 66920
0xffffef084	b0 05 01 00	pc	0x1057c 66940
0xffffef084	b0 05 01 00	cpsr	

mul에 의해 r0에 r12*r0가 저장된다. pc가 변경된다.

Registers			
address	hex	name	value (hex) value (decimal) description
0xffffef050	0xffffef097	r0	0x2 2
more		r1	0x0 0
0xffffef050	00 00 00 00	r2	0x0 0
0xffffef054	68 05 01 00	r3	0x89b20 564000
0xffffef058	01 00 00 00	r4	0x10d14 68884
0xffffef05c	68 05 01 00	r5	0x10158 65880
0xffffef060	02 00 00 00	r6	0x8b408 570376
0xffffef064	68 05 01 00	r7	0x10158 65880
0xffffef068	03 00 00 00	r8	0x0 0 register 8 (64-bit)
0xffffef06c	68 05 01 00	r9	0x0 0 register 9 (64-bit)
0xffffef070	04 00 00 00	r10	0x89b04 563972 register 10 (64-bit)
0xffffef074	68 05 01 00	r11	0xffffef094 4294897812 register 11 (64-bit)
0xffffef078	05 00 00 00	r12	0x1 1 register 12 (64-bit)
0xffffef07c	68 05 01 00	sp	0xffffef068 4294897768
0xffffef080	06 00 00 00	lr	0x10568 66920
0xffffef084	b0 05 01 00	pc	0x10568 66920

mov에 의해 pc가 lr값으로 변경된다.

memory				registers		
address	hex	name	value (hex)	value (decimal)	description	
0xffffef050	0xffffef097	r0	0x2	2		
more		r1	0x0	0		
0xffffef050	00 00 00 00	r2	0x0	0		
0xffffef054	68 05 01 00	r3	0x89b20	564000		
0xffffef058	01 00 00 00	r4	0x10d14	68884		
0xffffef05c	68 05 01 00	r5	0x10158	65880		
0xffffef060	02 00 00 00	r6	0x8b408	570376		
0xffffef064	68 05 01 00	r7	0x10158	65880		
0xffffef068	03 00 00 00	r8	0x0	0	register 8 (64-bit)	
0xffffef06c	68 05 01 00	r9	0x0	0	register 9 (64-bit)	
0xffffef070	04 00 00 00	r10	0x89b04	563972	register 10 (64-bit)	
0xffffef074	68 05 01 00	r11	0xffffef094	4294897812	register 11 (64-bit)	
0xffffef078	05 00 00 00	r12	0x2	2	register 12 (64-bit)	
0xffffef07c	68 05 01 00	lr	0x10568	66920		
0xffffef080	06 00 00 00	pc	0x1056c	66924		
0xffffef084	b0 05 01 00	cpsr				

mov에 의해 r12에 r0의 값을 저장한다. pc값이 변경된다.

memory				registers		
address	hex	name	value (hex)	value (decimal)	description	
0xffffef050	0xffffef097	r0	0x3	3		
more		r1	0x0	0		
0xffffef050	00 00 00 00	r2	0x0	0		
0xffffef054	68 05 01 00	r3	0x89b20	564000		
0xffffef058	01 00 00 00	r4	0x10d14	68884		
0xffffef05c	68 05 01 00	r5	0x10158	65880		
0xffffef060	02 00 00 00	r6	0x8b408	570376		
0xffffef064	68 05 01 00	r7	0x10158	65880		
0xffffef068	03 00 00 00	r8	0x0	0	register 8 (64-bit)	
0xffffef06c	68 05 01 00	r9	0x0	0	register 9 (64-bit)	
0xffffef070	04 00 00 00	r10	0x89b04	563972	register 10 (64-bit)	
0xffffef074	68 05 01 00	r11	0xffffef094	4294897812	register 11 (64-bit)	
0xffffef078	05 00 00 00	r12	0x2	2	register 12 (64-bit)	
0xffffef07c	68 05 01 00	sp	0xffffef068	4294897768		
0xffffef080	06 00 00 00	lr	0x10568	66920		
0xffffef084	b0 05 01 00	pc	0x10570	66928		

ldr에 의해 r0에 stack 최상단 값을 저장한다. pc값이 변경된다.

memory				registers		
address	hex	name	value (hex)	value (decimal)	description	
0xffffef050	0xffffef097	r0	0x3	3		
more		r1	0x0	0		
0xffffef050	00 00 00 00	r2	0x0	0		
0xffffef054	68 05 01 00	r3	0x89b20	564000		
0xffffef058	01 00 00 00	r4	0x10d14	68884		
0xffffef05c	68 05 01 00	r5	0x10158	65880		
0xffffef060	02 00 00 00	r6	0x8b408	570376		
0xffffef064	68 05 01 00	r7	0x10158	65880		
0xffffef068	03 00 00 00	r8	0x0	0	register 8 (64-bit)	
0xffffef06c	68 05 01 00	r9	0x0	0	register 9 (64-bit)	
0xffffef070	04 00 00 00	r10	0x89b04	563972	register 10 (64-bit)	
0xffffef074	68 05 01 00	r11	0xffffef094	4294897812	register 11 (64-bit)	
0xffffef078	05 00 00 00	r12	0x2	2	register 12 (64-bit)	
0xffffef07c	68 05 01 00	sp	0xffffef068	4294897768		
0xffffef080	06 00 00 00	lr	0x10568	66920		
0xffffef084	b0 05 01 00	pc	0x10574	66932		
		cpsr				

ldr에 의해 lr에 stack에서 pop한 lr값을 저장한다. pc가 변경된다.

.text		memory				registers				
		0xffffef050	0xffffef097	4	address	hex	name	value (hex)	value (decimal)	description
1	.text				0xffffef050	00 00 00 00	r0	0x3	3	
2	.global factRecursive				more		r1	0x0	0	
3					0xffffef050	68 05 01 00	r2	0x0	0	
4	factRecursive:				0xffffef054	01 00 00 00	r3	0x89b20	564000	
5	sub sp, sp, #8				0xffffef058	01 00 00 00	r4	0x10d14	68884	
6	str lr, [sp, #4]				0xffffef05c	68 05 01 00	r5	0x10158	65880	
7	str r0, [sp, #8]				0xffffef060	02 00 00 00	r6	0x8b408	570376	
8	cmp r0, #1				0xffffef064	68 05 01 00	r7	0x10158	65880	
9	bge loop				0xffffef068	03 00 00 00	r8	0x0	0	register 8 (64-bit)
10	mov r0, #1				0xffffef06c	68 05 01 00	r9	0x0	0	register 9 (64-bit)
11	add sp, sp, #8				0xffffef070	04 00 00 00	r10	0x89b04	563972	register 10 (64-bit)
12	mov pc,lr				0xffffef074	68 05 01 00	r11	0xffffef094	4294897812	register 11 (64-bit)
13	loop:				0xffffef078	05 00 00 00	r12	0x2	2	register 12 (64-bit)
14	sub r0, r0, #1				0xffffef07c	68 05 01 00	sp	0xffffef070	4294897776	
15	bl factRecursive				0xffffef080	06 00 00 00	lr	0x10568	66920	
16	mov r12, r0				0xffffef084	b0 05 01 00	pc	0x10578	66936	
17	ldr r0, [sp, #8]						cpsr			
18	ldr lr, [sp, #4]									
19	add sp, sp, #8									
20	mul r0, r12, r0									
21	mov pc, lr									
22	.end									
23										
24	(end of file)									

add에 의해 sp값에 8을 더한다. pc값이 변경된다.

.text		memory				registers				
		0xffffef050	0xffffef097	4	address	hex	name	value (hex)	value (decimal)	description
1	.text				0xffffef050	00 00 00 00	r0	0x6	6	
2	.global factRecursive				more		r1	0x0	0	
3					0xffffef050	68 05 01 00	r2	0x0	0	
4	factRecursive:				0xffffef054	01 00 00 00	r3	0x89b20	564000	
5	sub sp, sp, #8				0xffffef058	01 00 00 00	r4	0x10d14	68884	
6	str lr, [sp, #4]				0xffffef05c	68 05 01 00	r5	0x10158	65880	
7	str r0, [sp, #8]				0xffffef060	02 00 00 00	r6	0x8b408	570376	
8	cmp r0, #1				0xffffef064	68 05 01 00	r7	0x10158	65880	
9	bge loop				0xffffef068	03 00 00 00	r8	0x0	0	register 8 (64-bit)
10	mov r0, #1				0xffffef06c	68 05 01 00	r9	0x0	0	register 9 (64-bit)
11	add sp, sp, #8				0xffffef070	04 00 00 00	r10	0x89b04	563972	register 10 (64-bit)
12	mov pc,lr				0xffffef074	68 05 01 00	r11	0xffffef094	4294897812	register 11 (64-bit)
13	loop:				0xffffef078	05 00 00 00	r12	0x2	2	register 12 (64-bit)
14	sub r0, r0, #1				0xffffef07c	68 05 01 00	sp	0xffffef070	4294897776	
15	bl factRecursive				0xffffef080	06 00 00 00	lr	0x10568	66920	
16	mov r12, r0				0xffffef084	b0 05 01 00	pc	0x10578	66940	
17	ldr r0, [sp, #8]									
18	ldr lr, [sp, #4]									
19	add sp, sp, #8									
20	mul r0, r12, r0									
21	mov pc, lr									
22	.end									
23										
24	(end of file)									

mul에 의해 r0에 r0*r12의 값을 저장한다. pc값이 변경된다.

.text		memory				registers				
		0xffffef050	0xffffef097	4	address	hex	name	value (hex)	value (decimal)	description
1	.text				0xffffef050	00 00 00 00	r0	0x6	6	
2	.global factRecursive				more		r1	0x0	0	
3					0xffffef050	68 05 01 00	r2	0x0	0	
4	factRecursive:				0xffffef054	01 00 00 00	r3	0x89b20	564000	
5	sub sp, sp, #8				0xffffef058	01 00 00 00	r4	0x10d14	68884	
6	str lr, [sp, #4]				0xffffef05c	68 05 01 00	r5	0x10158	65880	
7	str r0, [sp, #8]				0xffffef060	02 00 00 00	r6	0x8b408	570376	
8	cmp r0, #1				0xffffef064	68 05 01 00	r7	0x10158	65880	
9	bge loop				0xffffef068	03 00 00 00	r8	0x0	0	register 8 (64-bit)
10	mov r0, #1				0xffffef06c	68 05 01 00	r9	0x0	0	register 9 (64-bit)
11	add sp, sp, #8				0xffffef070	04 00 00 00	r10	0x89b04	563972	register 10 (64-bit)
12	mov pc,lr				0xffffef074	68 05 01 00	r11	0xffffef094	4294897812	register 11 (64-bit)
13	loop:				0xffffef078	05 00 00 00	r12	0x2	2	register 12 (64-bit)
14	sub r0, r0, #1				0xffffef07c	68 05 01 00	sp	0xffffef070	4294897776	
15	bl factRecursive				0xffffef080	06 00 00 00	lr	0x10568	66920	
16	mov r12, r0				0xffffef084	b0 05 01 00	pc	0x10578	66940	
17	ldr r0, [sp, #8]									
18	ldr lr, [sp, #4]									
19	add sp, sp, #8									
20	mul r0, r12, r0									
21	mov pc, lr									
22	.end									
23										
24	(end of file)									

mov에 의해 pc의 값을 lr에 저장된 값으로 변경한다.

Registers			
name	value (hex)	value (decimal)	description
r0	0x6	6	
r1	0x0	0	
r2	0x0	0	
r3	0x89b20	564000	
r4	0x10d14	68884	
r5	0x10158	65880	
r6	0xb408	570376	
r7	0x10158	65880	
r8	0x0	0	register 8 (64-bit)
r9	0x0	0	register 9 (64-bit)
r10	0x89b04	563972	register 10 (64-bit)
r11	0xffffef094	4294897812	register 11 (64-bit)
r12	0x6	6	register 12 (64-bit)
sp	0xffffef070	4294897776	
lr	0x10568	66920	
pc	0x1056c	66924	
cpsr			

mov에 의해 r12에 r0의 값을 저장한다. pc값이 변경되었다.

Registers			
name	value (hex)	value (decimal)	description
r0	0x4	4	
r1	0x0	0	
r2	0x0	0	
r3	0x89b20	564000	
r4	0x10d14	68884	
r5	0x10158	65880	
r6	0xb408	570376	
r7	0x10158	65880	
r8	0x0	0	register 8 (64-bit)
r9	0x0	0	register 9 (64-bit)
r10	0x89b04	563972	register 10 (64-bit)
r11	0xffffef094	4294897812	register 11 (64-bit)
r12	0x6	6	register 12 (64-bit)
sp	0xffffef070	4294897776	
lr	0x10568	66920	
pc	0x10570	66928	
cpsr			

ldr로 stack 최상단 값을 pop해 r0에 저장한다. pc가 변경된다.

Registers			
name	value (hex)	value (decimal)	description
r0	0x4	4	
r1	0x0	0	
r2	0x0	0	
r3	0x89b20	564000	
r4	0x10d14	68884	
r5	0x10158	65880	
r6	0xb408	570376	
r7	0x10158	65880	
r8	0x0	0	register 8 (64-bit)
r9	0x0	0	register 9 (64-bit)
r10	0x89b04	563972	register 10 (64-bit)
r11	0xffffef094	4294897812	register 11 (64-bit)
r12	0x6	6	register 12 (64-bit)
sp	0xffffef070	4294897776	
lr	0x10568	66920	
pc	0x10574	66932	
cpsr			

ldr로 stack에서 값을 pop해 lr에 저장한다. pc가 변경된다.

registers			
memory	name	value (hex)	value (decimal)
0xffffef050 0xffffef097 4	r0	0x4	4
address hex	r1	0x0	0
more	r2	0x0	0
0xffffef050 00 00 00 00	r3	0x89b20	564000
0xffffef054 68 05 01 00	r4	0x10d14	68884
0xffffef058 01 00 00 00	r5	0x10158	65880
0xffffef05c 68 05 01 00	r6	0x8b408	570376
0xffffef060 02 00 00 00	r7	0x10158	65880
0xffffef064 68 05 01 00	r8	0x0	0
0xffffef068 03 00 00 00	r9	0x0	0
0xffffef06c 68 05 01 00	r10	0x89b04	563972
0xffffef070 04 00 00 00	r11	0xffffef094	4294897812
0xffffef074 68 05 01 00	r12	0x6	6
0xffffef078 05 00 00 00	sp	0xffffef078	4294897784
0xffffef07c 68 05 01 00	lr	0x10568	66920
0xffffef080 06 00 00 00	pc	0x10578	66936
0xffffef084 b0 05 01 00	cpsr		

add로 sp의 값을 8만큼 증가시킨다. pc가 변경되었다.

registers			
memory	name	value (hex)	value (decimal)
0xffffef050 0xffffef097 4	r0	0x18	24
address hex	r1	0x0	0
more	r2	0x0	0
0xffffef050 00 00 00 00	r3	0x89b20	564000
0xffffef054 68 05 01 00	r4	0x10d14	68884
0xffffef058 01 00 00 00	r5	0x10158	65880
0xffffef05c 68 05 01 00	r6	0x8b408	570376
0xffffef060 02 00 00 00	r7	0x10158	65880
0xffffef064 68 05 01 00	r8	0x0	0
0xffffef068 03 00 00 00	r9	0x0	0
0xffffef06c 68 05 01 00	r10	0x89b04	563972
0xffffef070 04 00 00 00	r11	0xffffef094	4294897812
0xffffef074 68 05 01 00	r12	0x6	6
0xffffef078 05 00 00 00	sp	0xffffef078	4294897784
0xffffef07c 68 05 01 00	lr	0x10568	66920
0xffffef080 06 00 00 00	pc	0x1057c	66940
0xffffef084 b0 05 01 00	cpsr		

mul에 의해 r0에 r0*r12값이 저장된다. pc가 변경되었다.

registers			
memory	name	value (hex)	value (decimal)
0xffffef050 0xffffef097 4	r0	0x18	24
address hex	r1	0x0	0
more	r2	0x0	0
0xffffef050 00 00 00 00	r3	0x89b20	564000
0xffffef054 68 05 01 00	r4	0x10d14	68884
0xffffef058 01 00 00 00	r5	0x10158	65880
0xffffef05c 68 05 01 00	r6	0x8b408	570376
0xffffef060 02 00 00 00	r7	0x10158	65880
0xffffef064 68 05 01 00	r8	0x0	0
0xffffef068 03 00 00 00	r9	0x0	0
0xffffef06c 68 05 01 00	r10	0x89b04	563972
0xffffef070 04 00 00 00	r11	0xffffef094	4294897812
0xffffef074 68 05 01 00	r12	0x6	6
0xffffef078 05 00 00 00	sp	0xffffef078	4294897784
0xffffef07c 68 05 01 00	lr	0x10568	66920
0xffffef080 06 00 00 00	pc	0x10568	66920
0xffffef084 b0 05 01 00	cpsr		

mov에 의해 pc에 lr이 저장된다. pc가 변경되었다.

memory				registers		
address	hex	name	value (hex)	value (decimal)	description	
0xffffef050	0xffffef097	r0	0x18	24		
		more	0x0	0		
0xffffef050	00 00 00 00	r2	0x0	0		
0xffffef054	68 05 01 00	r3	0x89b20	564000		
0xffffef058	01 00 00 00	r4	0x10d14	68884		
0xffffef05c	68 05 01 00	r5	0x10158	65880		
0xffffef060	02 00 00 00	r6	0x8b408	570376		
0xffffef064	68 05 01 00	r7	0x10158	65880		
0xffffef068	03 00 00 00	r8	0x0	0	register 8 (64-bit)	
0xffffef06c	68 05 01 00	r9	0x0	0	register 9 (64-bit)	
0xffffef070	04 00 00 00	r10	0x89b04	563972	register 10 (64-bit)	
0xffffef074	68 05 01 00	r11	0xffffef094	4294897812	register 11 (64-bit)	
0xffffef078	05 00 00 00	r12	0x18	24	register 12 (64-bit)	
0xffffef07c	68 05 01 00	sp	0xffffef078	4294897784		
0xffffef080	06 00 00 00	lr	0x10568	66920		
0xffffef084	b0 05 01 00	pc	0x1056c	66924		
		cpsr				

mov에 의해 r0값이 r12에 저장된다. pc가 변경된다.

memory				registers		
address	hex	name	value (hex)	value (decimal)	description	
0xffffef050	0xffffef097	r0	0x5	5		
		more	0x0	0		
0xffffef050	00 00 00 00	r2	0x0	0		
0xffffef054	68 05 01 00	r3	0x89b20	564000		
0xffffef058	01 00 00 00	r4	0x10d14	68884		
0xffffef05c	68 05 01 00	r5	0x10158	65880		
0xffffef060	02 00 00 00	r6	0x8b408	570376		
0xffffef064	68 05 01 00	r7	0x10158	65880		
0xffffef068	03 00 00 00	r8	0x0	0	register 8 (64-bit)	
0xffffef06c	68 05 01 00	r9	0x0	0	register 9 (64-bit)	
0xffffef070	04 00 00 00	r10	0x89b04	563972	register 10 (64-bit)	
0xffffef074	68 05 01 00	r11	0xffffef094	4294897812	register 11 (64-bit)	
0xffffef078	05 00 00 00	r12	0x18	24	register 12 (64-bit)	
0xffffef07c	68 05 01 00	sp	0xffffef078	4294897784		
0xffffef080	06 00 00 00	lr	0x10568	66920		
0xffffef084	b0 05 01 00	pc	0x10570	66928		

ldr에 의해 r0에 stack에서 pop된 값이 저장된다. pc가 변경된다.

memory				registers		
address	hex	name	value (hex)	value (decimal)	description	
0xffffef050	0xffffef097	r0	0x5	5		
		more	0x0	0		
0xffffef050	00 00 00 00	r2	0x0	0		
0xffffef054	68 05 01 00	r3	0x89b20	564000		
0xffffef058	01 00 00 00	r4	0x10d14	68884		
0xffffef05c	68 05 01 00	r5	0x10158	65880		
0xffffef060	02 00 00 00	r6	0x8b408	570376		
0xffffef064	68 05 01 00	r7	0x10158	65880		
0xffffef068	03 00 00 00	r8	0x0	0	register 8 (64-bit)	
0xffffef06c	68 05 01 00	r9	0x0	0	register 9 (64-bit)	
0xffffef070	04 00 00 00	r10	0x89b04	563972	register 10 (64-bit)	
0xffffef074	68 05 01 00	r11	0xffffef094	4294897812	register 11 (64-bit)	
0xffffef078	05 00 00 00	r12	0x18	24	register 12 (64-bit)	
0xffffef07c	68 05 01 00	sp	0xffffef078	4294897784		
0xffffef080	06 00 00 00	lr	0x10568	66920		
0xffffef084	b0 05 01 00	pc	0x10574	66932		
		cpsr				

ldr에 의해 lr에 stack에서 pop된 값이 저장된다. pc가 변경된다.

Registers			
Memory	Address	Value (hex)	Description
0xffffef050	0xffffef097	4	r0
		0x5	5
more		r1	0x0
0xffffef050	00 00 00 00	r2	0x0
0xffffef054	68 05 01 00	r3	0x89b20
0xffffef058	01 00 00 00	r4	0x10d14
0xffffef05c	68 05 01 00	r5	0x10158
0xffffef060	02 00 00 00	r6	0x8b408
0xffffef064	68 05 01 00	r7	0x10158
0xffffef068	03 00 00 00	r8	0x0
0xffffef06c	68 05 01 00	r9	0x0
0xffffef070	04 00 00 00	r10	0x89b04
0xffffef074	68 05 01 00	r11	0xffffef094
0xffffef078	05 00 00 00	r12	0x18
0xffffef07c	68 05 01 00	sp	0xffffef080
0xffffef080	06 00 00 00	lr	0x10568
0xffffef084	b0 05 01 00	pc	0x10578
		cpsr	66936

add에 의해 sp값이 8만큼 증가한다. pc가 변경되었다.

Registers			
Memory	Address	Value (hex)	Description
0xffffef050	0xffffef097	4	r0
		0x78	120
more		r1	0x0
0xffffef050	00 00 00 00	r2	0x0
0xffffef054	68 05 01 00	r3	0x89b20
0xffffef058	01 00 00 00	r4	0x10d14
0xffffef05c	68 05 01 00	r5	0x10158
0xffffef060	02 00 00 00	r6	0x8b408
0xffffef064	68 05 01 00	r7	0x10158
0xffffef068	03 00 00 00	r8	0x0
0xffffef06c	68 05 01 00	r9	0x0
0xffffef070	04 00 00 00	r10	0x89b04
0xffffef074	68 05 01 00	r11	0xffffef094
0xffffef078	05 00 00 00	r12	0x18
0xffffef07c	68 05 01 00	sp	0xffffef080
0xffffef080	06 00 00 00	lr	0x10568
0xffffef084	b0 05 01 00	pc	0x1057c

mul에 의해 r0에 r0*r12의 값이 저장된다. pc가 변경되었다.

Registers			
Memory	Address	Value (hex)	Description
0xffffef050	0xffffef097	4	r0
		0x78	120
more		r1	0x0
0xffffef050	00 00 00 00	r2	0x0
0xffffef054	68 05 01 00	r3	0x89b20
0xffffef058	01 00 00 00	r4	0x10d14
0xffffef05c	68 05 01 00	r5	0x10158
0xffffef060	02 00 00 00	r6	0x8b408
0xffffef064	68 05 01 00	r7	0x10158
0xffffef068	03 00 00 00	r8	0x0
0xffffef06c	68 05 01 00	r9	0x0
0xffffef070	04 00 00 00	r10	0x89b04
0xffffef074	68 05 01 00	r11	0xffffef094
0xffffef078	05 00 00 00	r12	0x18
0xffffef07c	68 05 01 00	sp	0xffffef080
0xffffef080	06 00 00 00	lr	0x10568
0xffffef084	b0 05 01 00	pc	0x1057c

mov에 의해 pc에 lr값이 저장된다. pc가 변경되었다.

Registers			
name	value (hex)	value (decimal)	description
r0	0x78	120	
r1	0x0	0	
r2	0x0	0	
r3	0x89b20	564000	
r4	0x10d14	68884	
r5	0x10158	65880	
r6	0x8b408	570376	
r7	0x10158	65880	
r8	0x0	0	register 8 (64-bit)
r9	0x0	0	register 9 (64-bit)
r10	0x89b04	563972	register 10 (64-bit)
r11	0xffffef094	4294897812	register 11 (64-bit)
r12	0x78	120	register 12 (64-bit)
sp	0xffffef080	4294897792	
lr	0x10568	66920	
pc	0x1056c	66924	
cpsr	b0 05 01 00		

mov에 의해 r12에 r0의 값을 저장한다. pc가 변경된다.

Registers			
name	value (hex)	value (decimal)	description
r0	0x6	6	
r1	0x0	0	
r2	0x0	0	
r3	0x89b20	564000	
r4	0x10d14	68884	
r5	0x10158	65880	
r6	0x8b408	570376	
r7	0x10158	65880	
r8	0x0	0	register 8 (64-bit)
r9	0x0	0	register 9 (64-bit)
r10	0x89b04	563972	register 10 (64-bit)
r11	0xffffef094	4294897812	register 11 (64-bit)
r12	0x78	120	register 12 (64-bit)
sp	0xffffef080	4294897792	
lr	0x10568	66920	
pc	0x10570	66928	
cpsr	b0 05 01 00		

ldr에 의해 r0에 stack에서 pop한 값이 저장된다. pc가 변경되었다.

Registers			
name	value (hex)	value (decimal)	description
r0	0x6	6	
r1	0x0	0	
r2	0x0	0	
r3	0x89b20	564000	
r4	0x10d14	68884	
r5	0x10158	65880	
r6	0x8b408	570376	
r7	0x10158	65880	
r8	0x0	0	register 8 (64-bit)
r9	0x0	0	register 9 (64-bit)
r10	0x89b04	563972	register 10 (64-bit)
r11	0xffffef094	4294897812	register 11 (64-bit)
r12	0x78	120	register 12 (64-bit)
sp	0xffffef080	4294897792	
lr	0x105b0	66992	
pc	0x10574	66932	
cpsr	b0 05 01 00		

ldr에 의해 lr에 stack에서 pop한 값이 저장된다. pc가 변경되었다.

registers			
name	value (hex)	value (decimal)	description
r0	0x6	6	
r1	0x0	0	
r2	0x0	0	
r3	0x89b20	564000	
r4	0x10d14	68884	
r5	0x10158	65880	
r6	0x8b408	570376	
r7	0x10158	65880	
r8	0x0	0	register 8 (64-bit)
r9	0x0	0	register 9 (64-bit)
r10	0x89b04	563972	register 10 (64-bit)
r11	0xffffef094	4294897812	register 11 (64-bit)
r12	0x78	120	register 12 (64-bit)
sp	0xffffef088	4294897800	
lr	0x105b0	66992	
pc	0x10578	66936	
cpsr			

add에 의해 sp를 8만큼 증가시킨다. pc가 변경되었다.

registers			
name	value (hex)	value (decimal)	description
r0	0x2d0	720	
r1	0x0	0	
r2	0x0	0	
r3	0x89b20	564000	
r4	0x10d14	68884	
r5	0x10158	65880	
r6	0x8b408	570376	
r7	0x10158	65880	
r8	0x0	0	register 8 (64-bit)
r9	0x0	0	register 9 (64-bit)
r10	0x89b04	563972	register 10 (64-bit)
r11	0xffffef094	4294897812	register 11 (64-bit)
r12	0x78	120	register 12 (64-bit)
sp	0xffffef088	4294897800	
lr	0x105b0	66992	
pc	0x1057c	66940	
cpsr			

mul에 의해 r0에 r0*r12가 저장된다. pc가 변경되었다.

registers			
name	value (hex)	value (decimal)	description
r0	0x2d0	720	
r1	0x0	0	
r2	0x0	0	
r3	0x89b20	564000	
r4	0x10d14	68884	
r5	0x10158	65880	
r6	0x8b408	570376	
r7	0x10158	65880	
r8	0x0	0	register 8 (64-bit)
r9	0x0	0	register 9 (64-bit)
r10	0x89b04	563972	register 10 (64-bit)
r11	0xffffef094	4294897812	register 11 (64-bit)
r12	0x78	120	register 12 (64-bit)
sp	0xffffef088	4294897800	
lr	0x105b0	66992	
pc	0x105b4	66996	
cpsr			

mov에 의해 lr이 pc에 저장되었다. pc는 return한 뒤 다음 명령어의 주소를 가리키고 있다.

실습 B : 실습 A에서 8번, 9번 코드 수행 후 10번 코드 또는 14번 코드를 수행하게 되는데 어떤 상황에서 10번 코드를 수행하게 되는지 이유를 CPSR을 이용해 설명하시오.

-> 8번 코드는 cmp r0 #1이다. cmp 명령어는 sub 연산을 통해 operand 간의 대소를 비교하고 빨센 결과 자체는 저장하지 않고, cpsr 내 Condition bit의 N, Z, C, V 값을 갱신시킨다. 갱신된 Condition bit 값은 9번 bge loop에 전달된다. bge는 앞의 cmp의 인수들의 비교로 분기하게 되는데 cmp의 1번 인수가 2번 인수보다 크거나 작으면 분기한다. 각 변수가 unsigned가 아닌 signed이므로 cpsr 값 중 N과 Z의 EXOR 연산 결과가 0일 때 14번 코드로 분기하고, 1일 때 10번 코드로 분기하게 된다. N과 Z의 EXOR 연산 결과가 0일 때는 r0의 값이 1미만일 때의 경우고, 1일 때는 r0의 값이 1이상일 때의 경우다.