Buffer Overflow Example

Slides done by Magnus Almgren

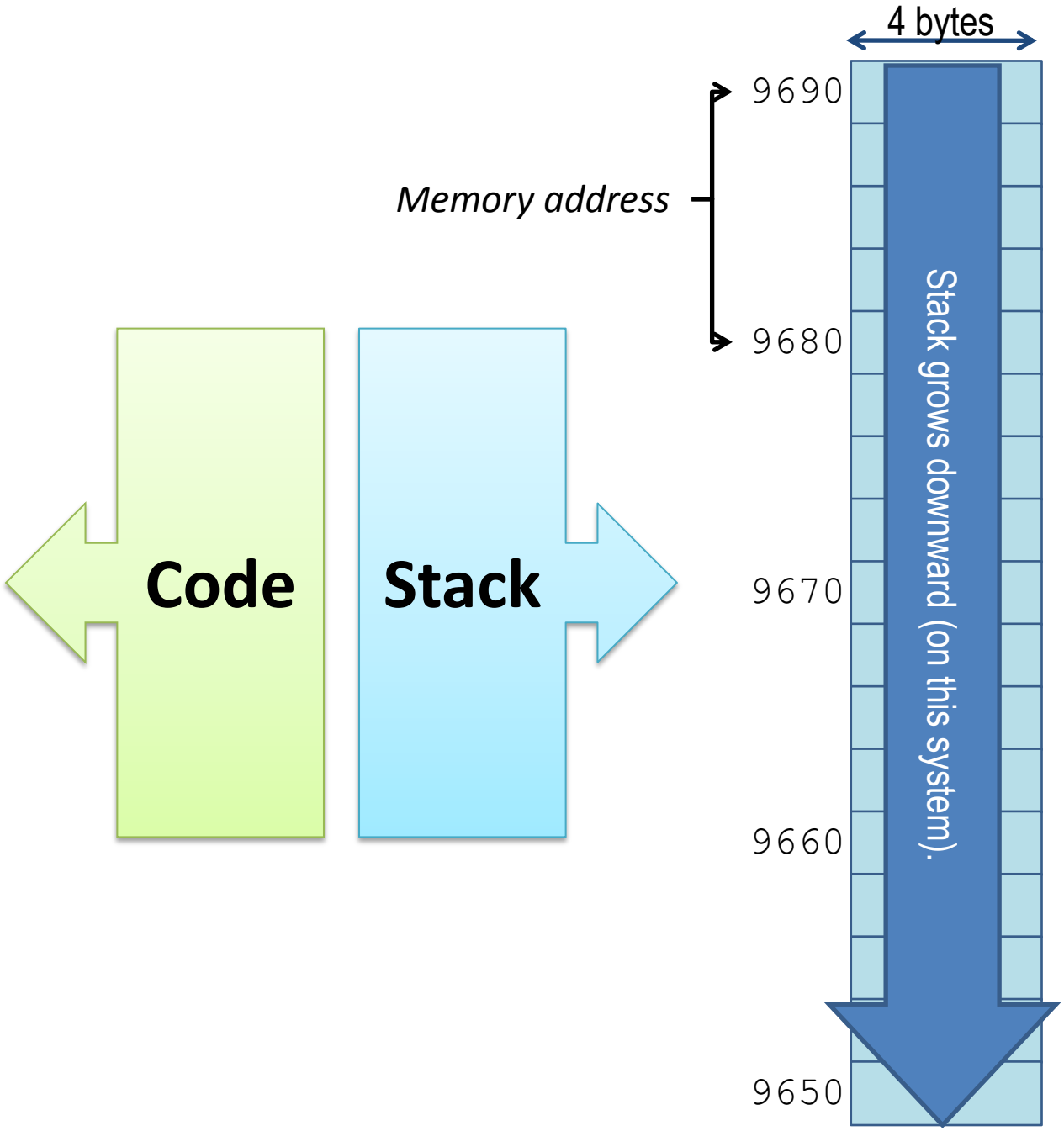
Source code of program example

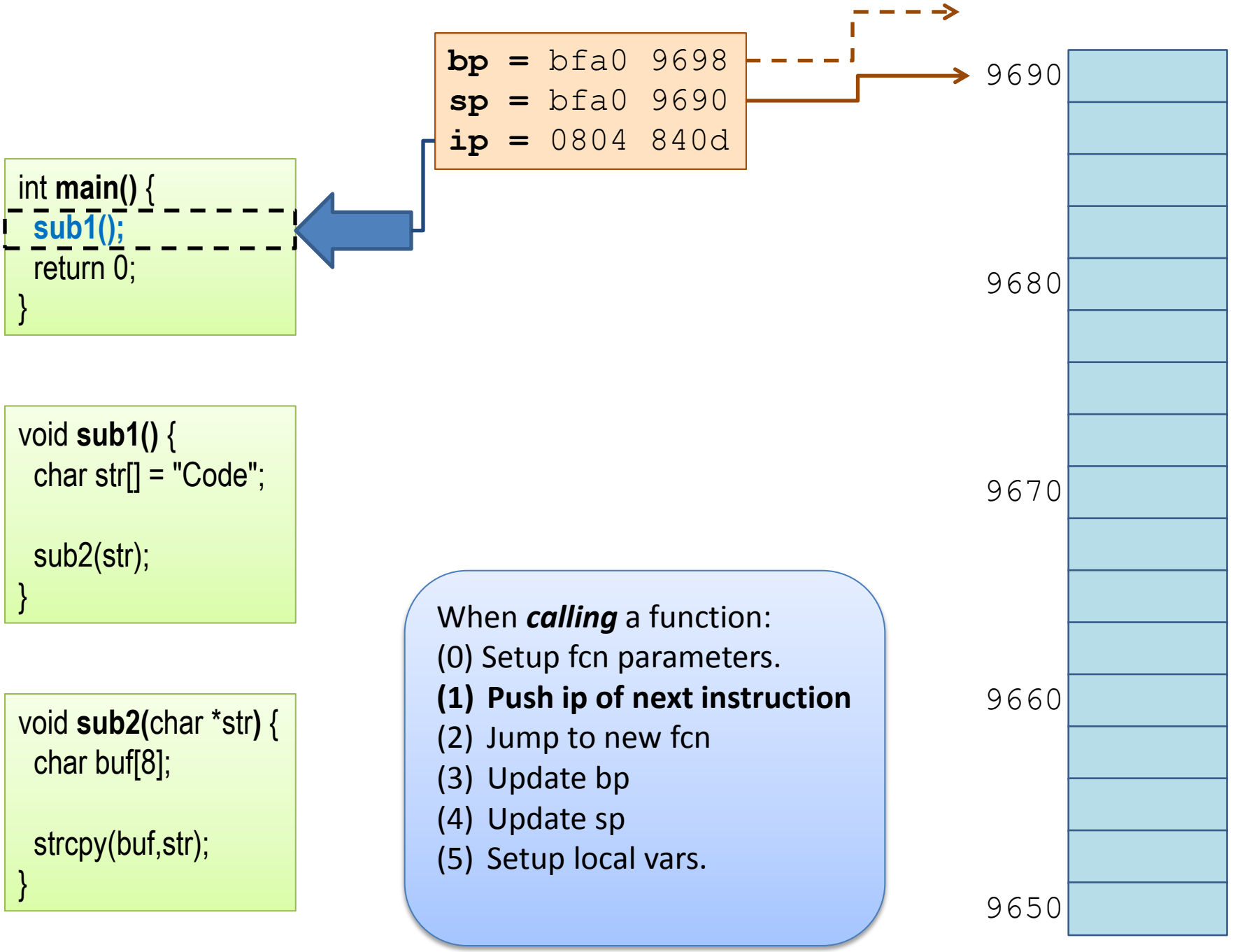
```
#include <string.h>

void sub2(char *str) {
  char buf[8];

  strcpy(buf,str);
}

void sub1() {
  char str[] = "Code";

  sub2(str);
}

int main() {
  sub1();
  return 0;
}
```

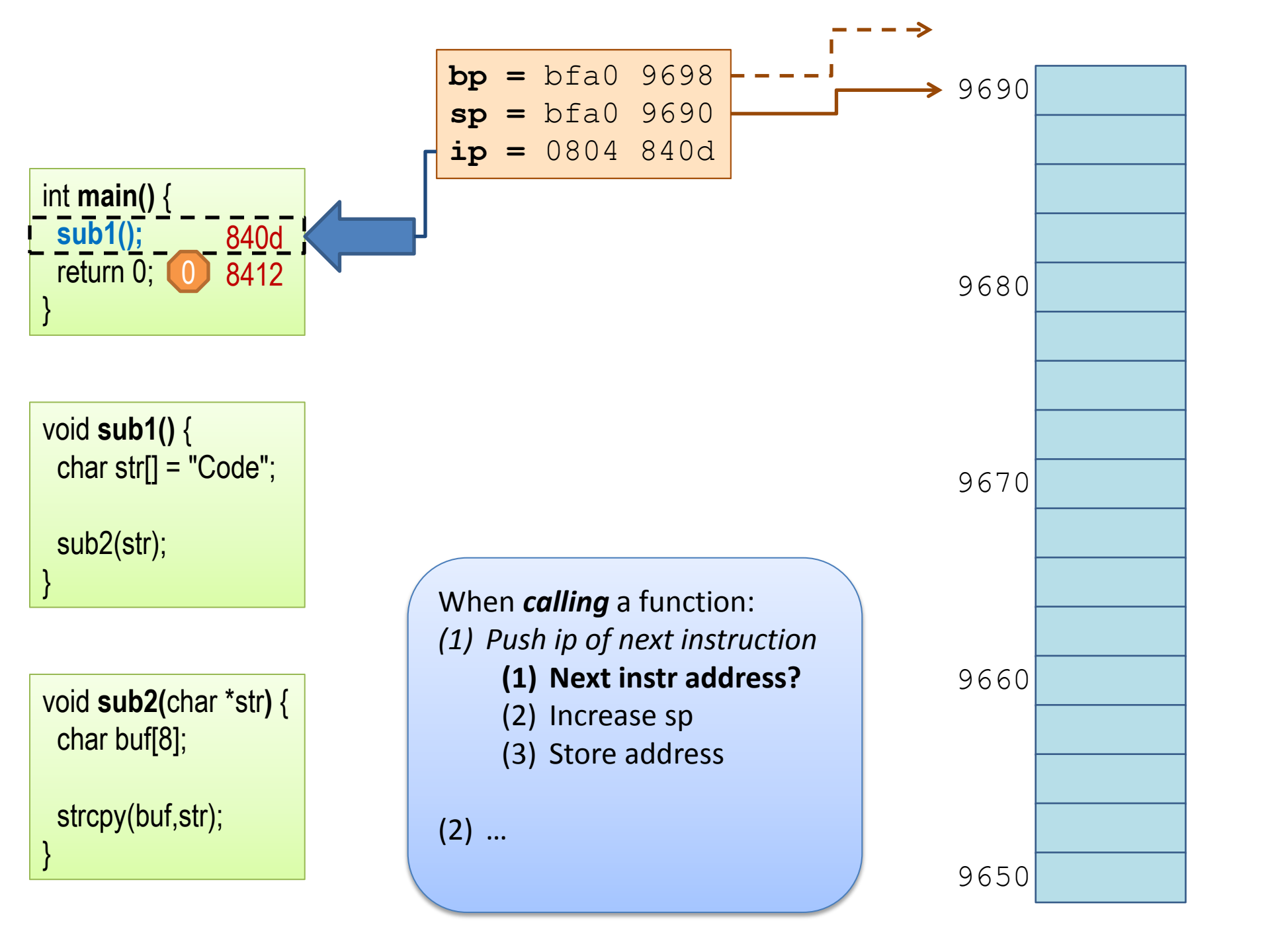
```
int main() {
  sub1();
  return 0;
}
```

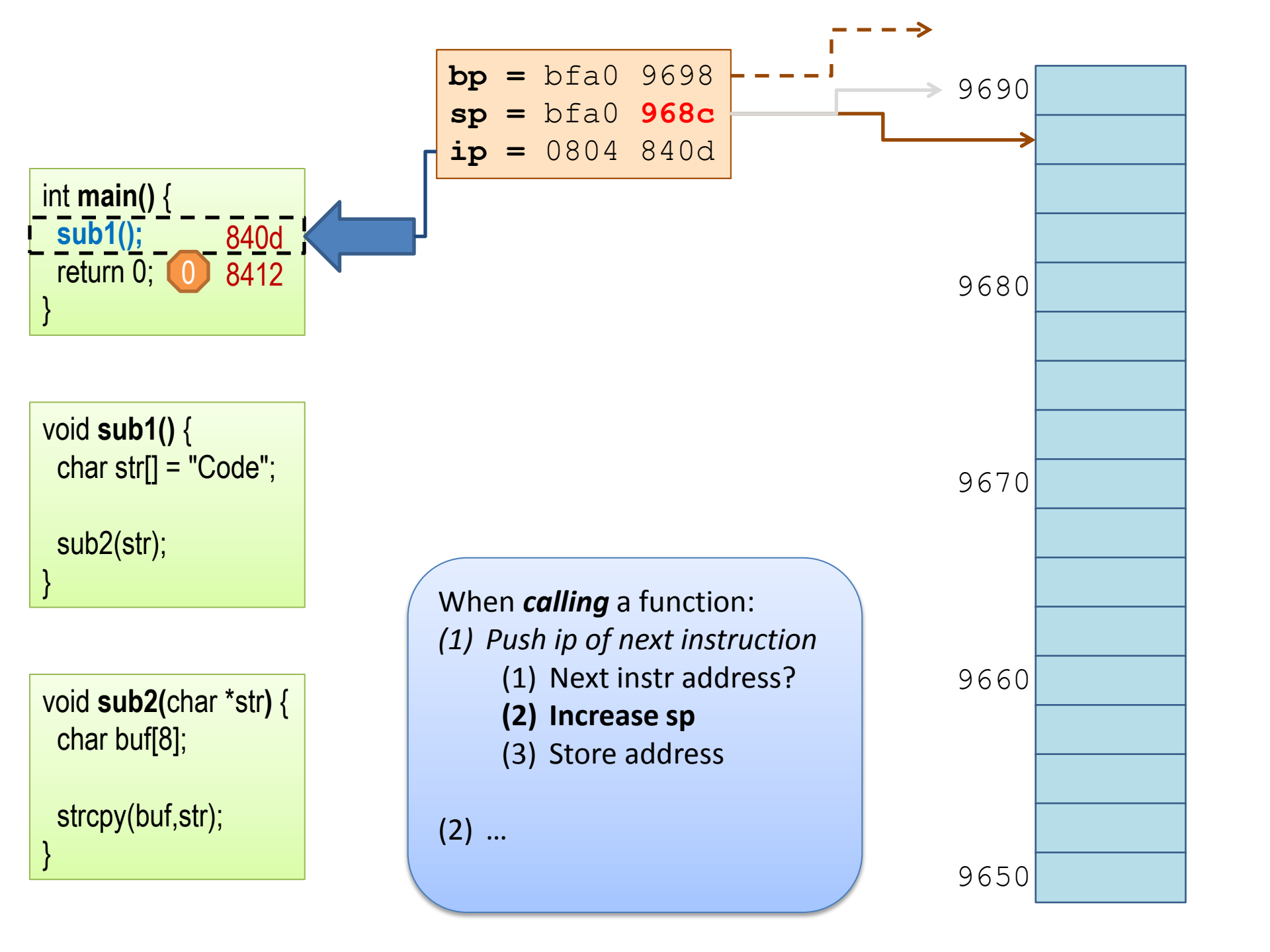
```
void sub1() {
  char str[] = "Code";

  sub2(str);
}
```

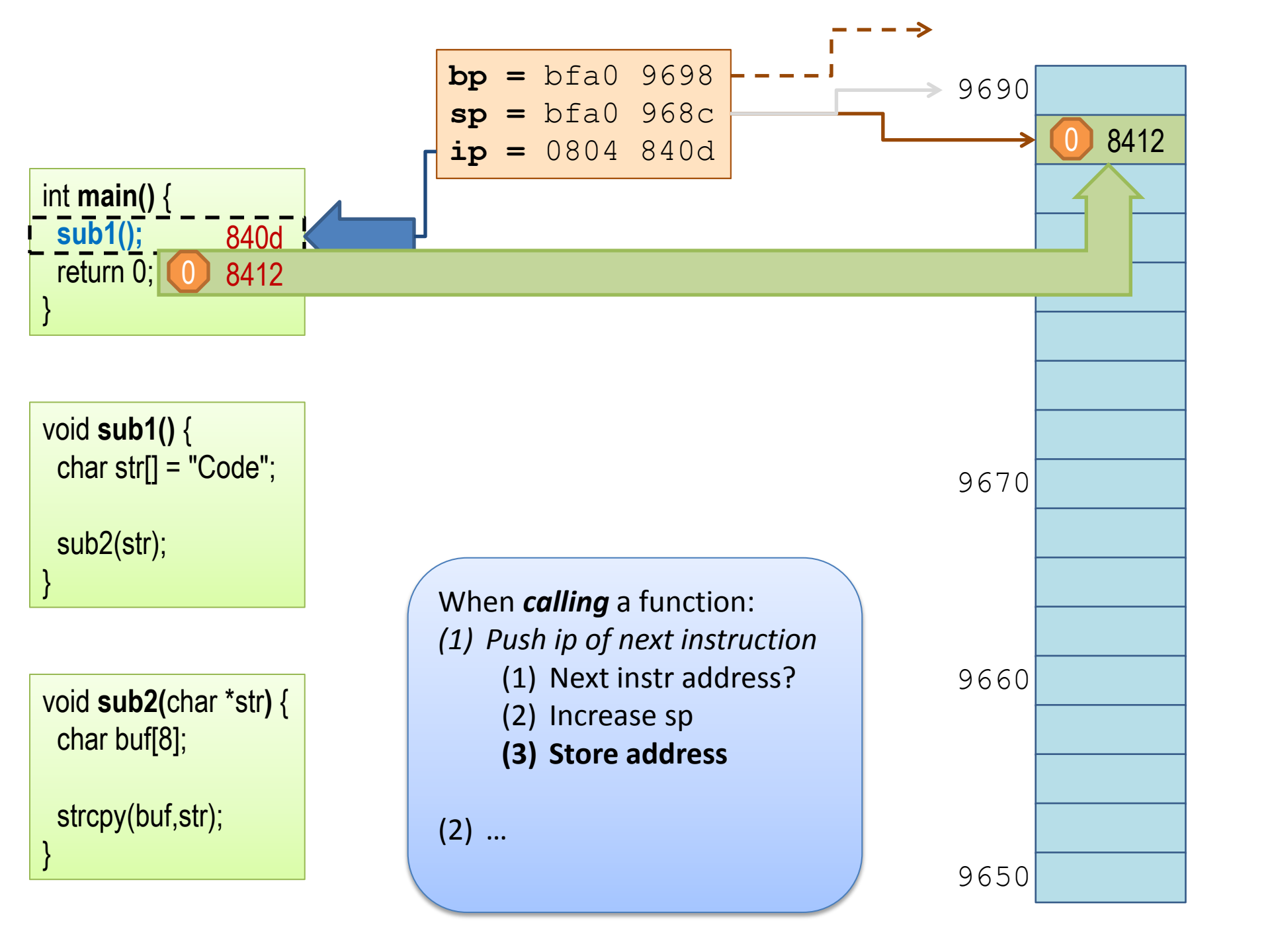
```
void sub2(char *str) {
  char buf[8];

  strcpy(buf,str);
}
```

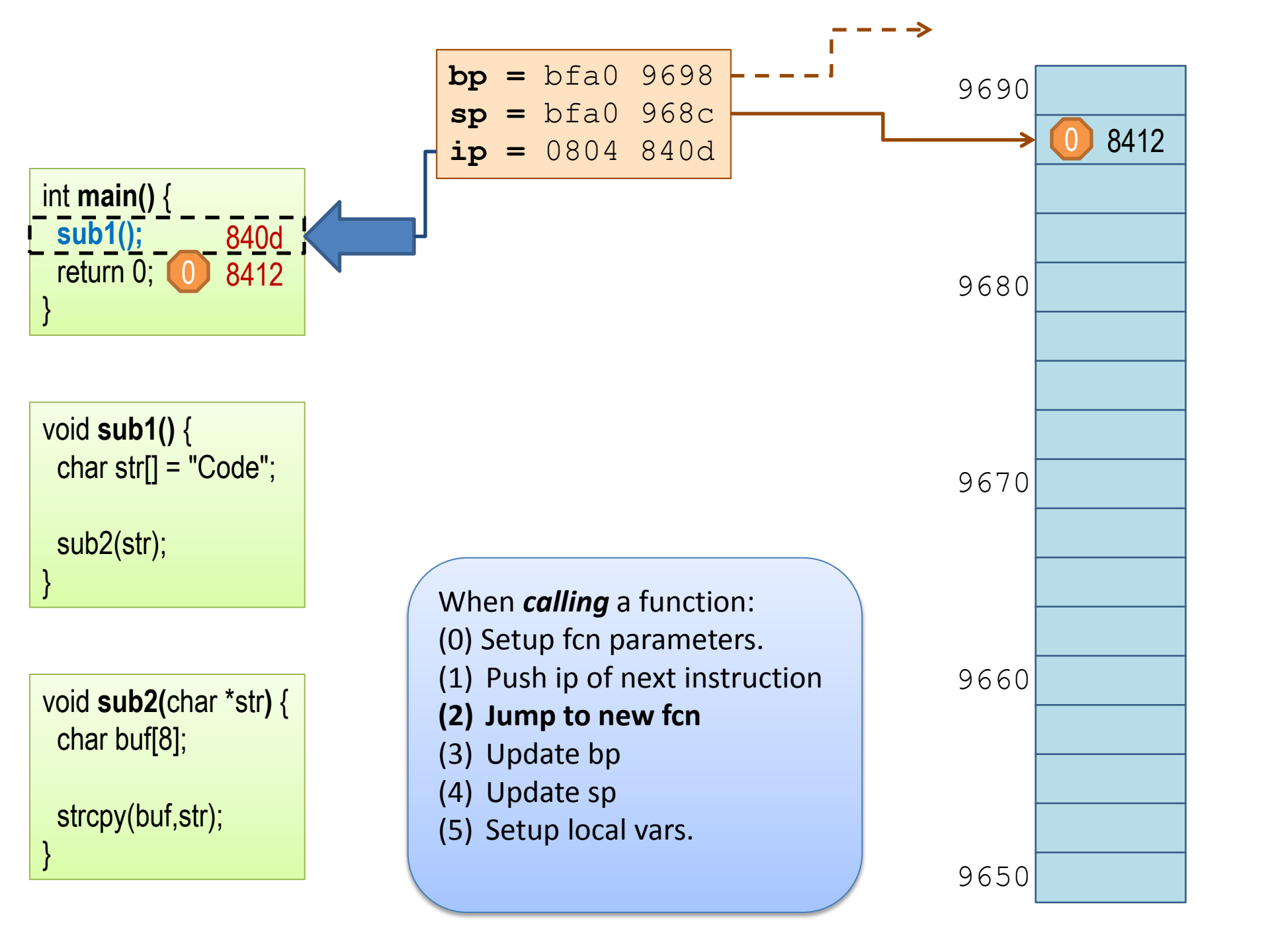


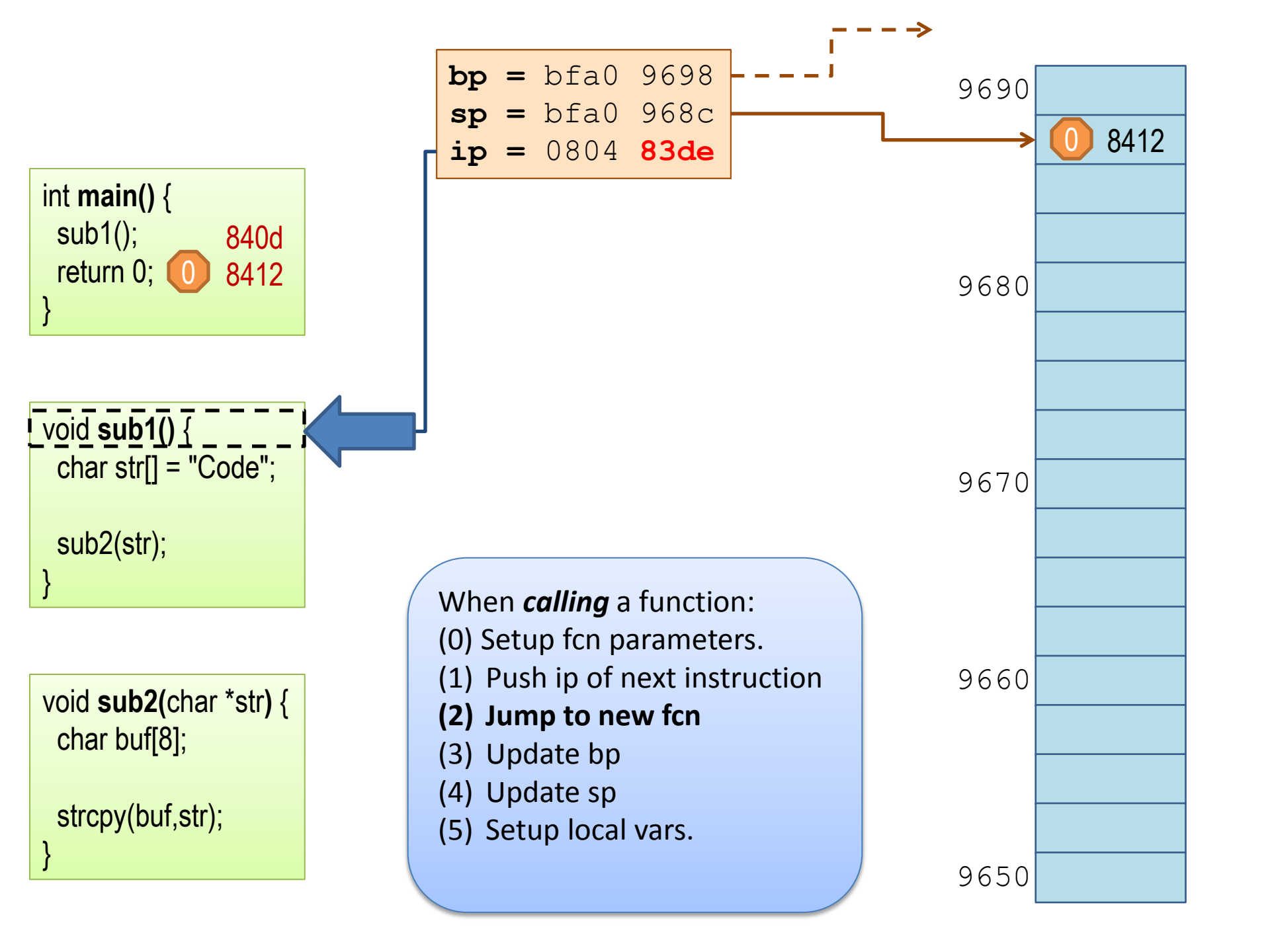

bp = bfa0 9698
sp = bfa0 9690
ip = 0804 840d
int main() {
sub1();
return 0;
}
void sub1() {
char str[] = "Code";
sub2(str);
}
void sub2(char *str) {
char buf[8];
strcpy(buf,str);
}
When calling a function:
(0) Setup fcn parameters.
(1) Push ip of next instruction
(2) Jump to new fcn
(3) Update bp
(4) Update sp
(5) Setup local vars.
9690
9680
9670
9660
9650

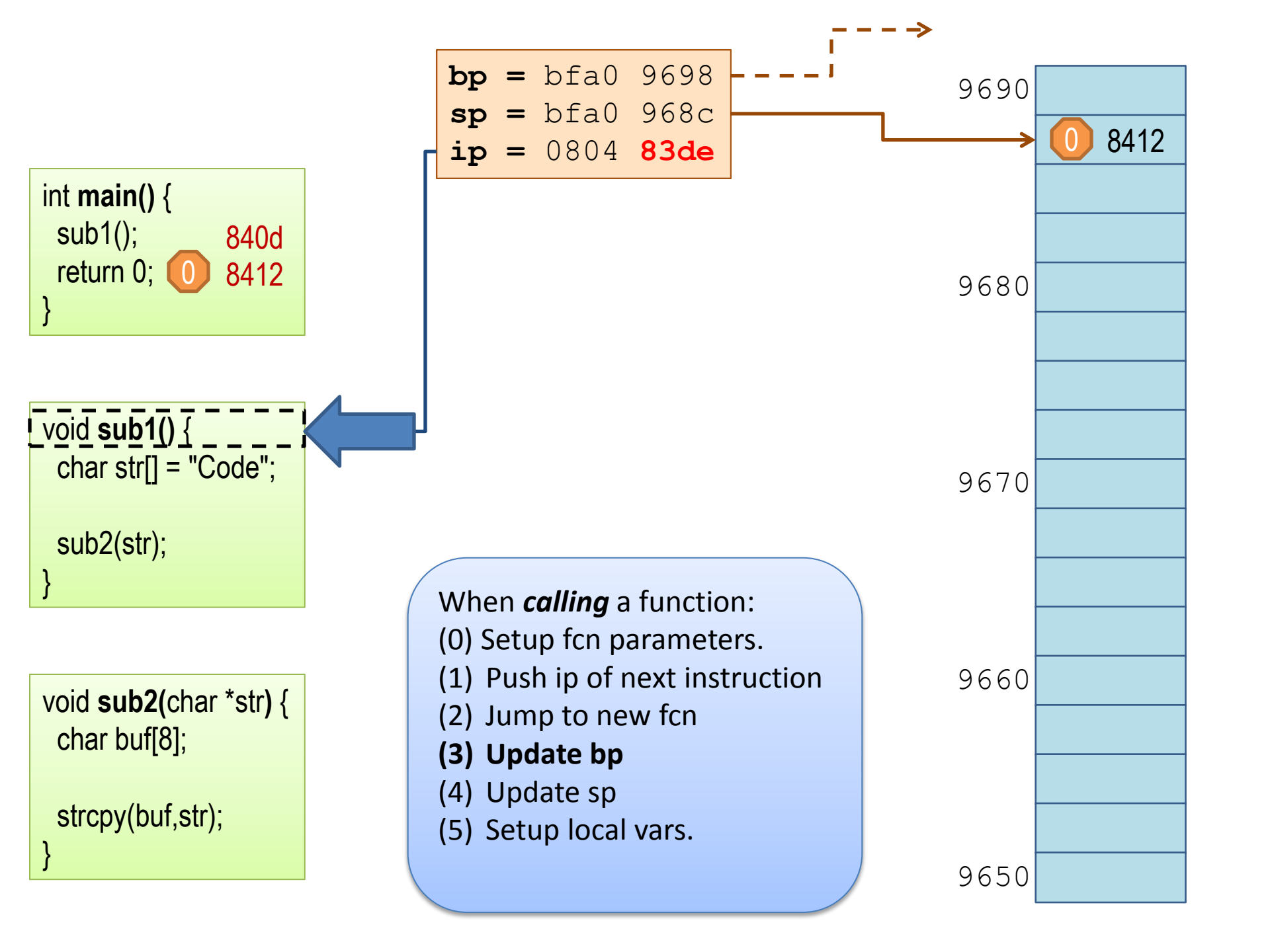

bp = bfa0 9698
sp = bfa0 9690
ip = 0804 840d
int main() {
sub1();
840d
return 0;
0
8412
}
void sub1() {
char str[] = "Code";
sub2(str);
}
void sub2(char *str) {
char buf[8];
strcpy(buf,str);
}
When calling a function:
(1) Push ip of next instruction
(1) Next instr address?
(2) Increase sp
(3) Store address
(2) …
9690
9680
9670
9660
9650

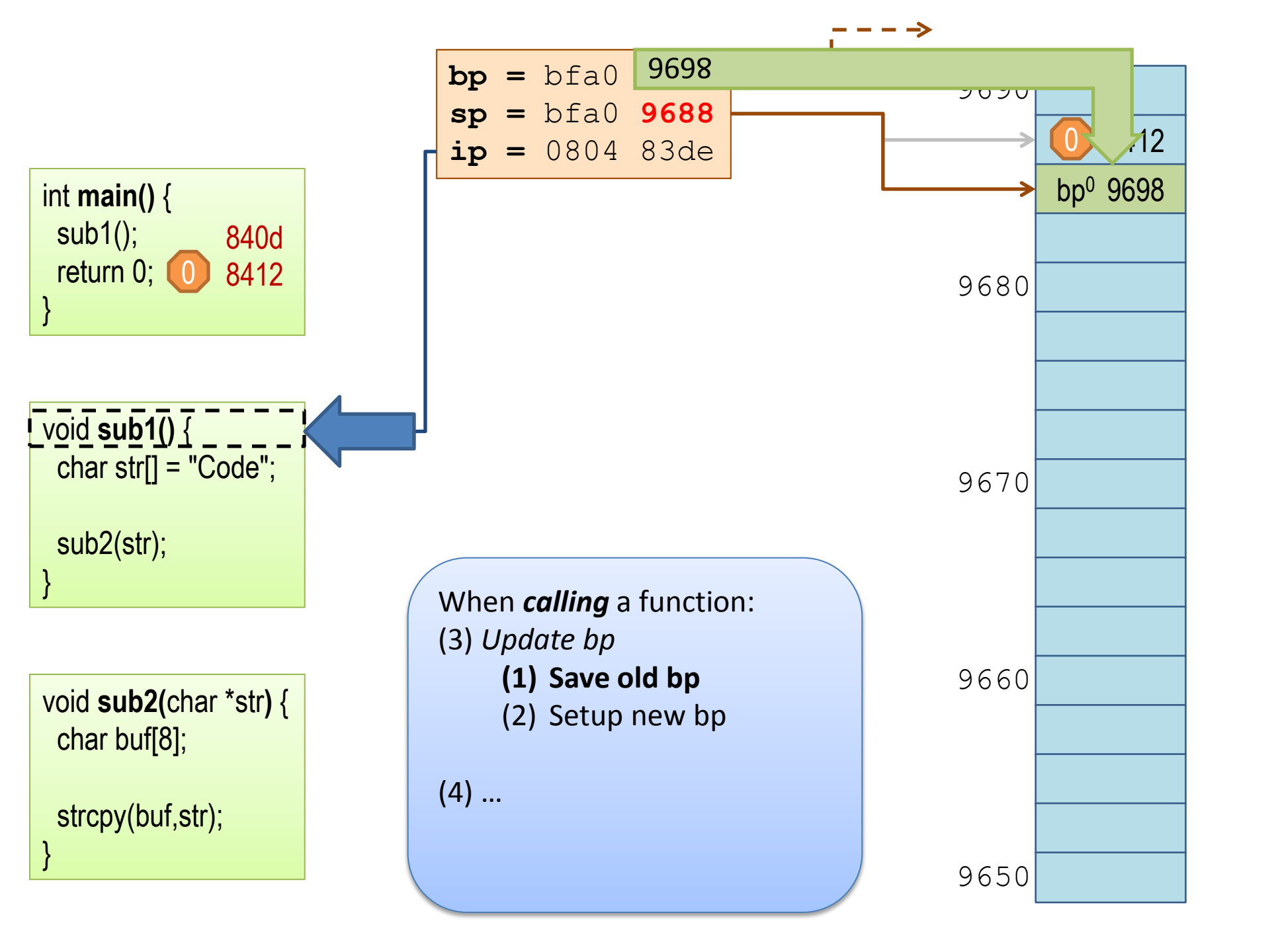

bp = bfa0 9698
sp = bfa0 968c
ip = 0804 840d
int main() {
sub1(); 840d
return 0; 0 8412
}
void sub1() {
char str[] = "Code";
sub2(str);
}
void sub2(char *str) {
char buf[8];
strcpy(buf,str);
}
9690
9680
9670
9660
9650
When calling a function:
(1) Push ip of next instruction
(1) Next instr address?
(2) Increase sp
(3) Store address
(2) …

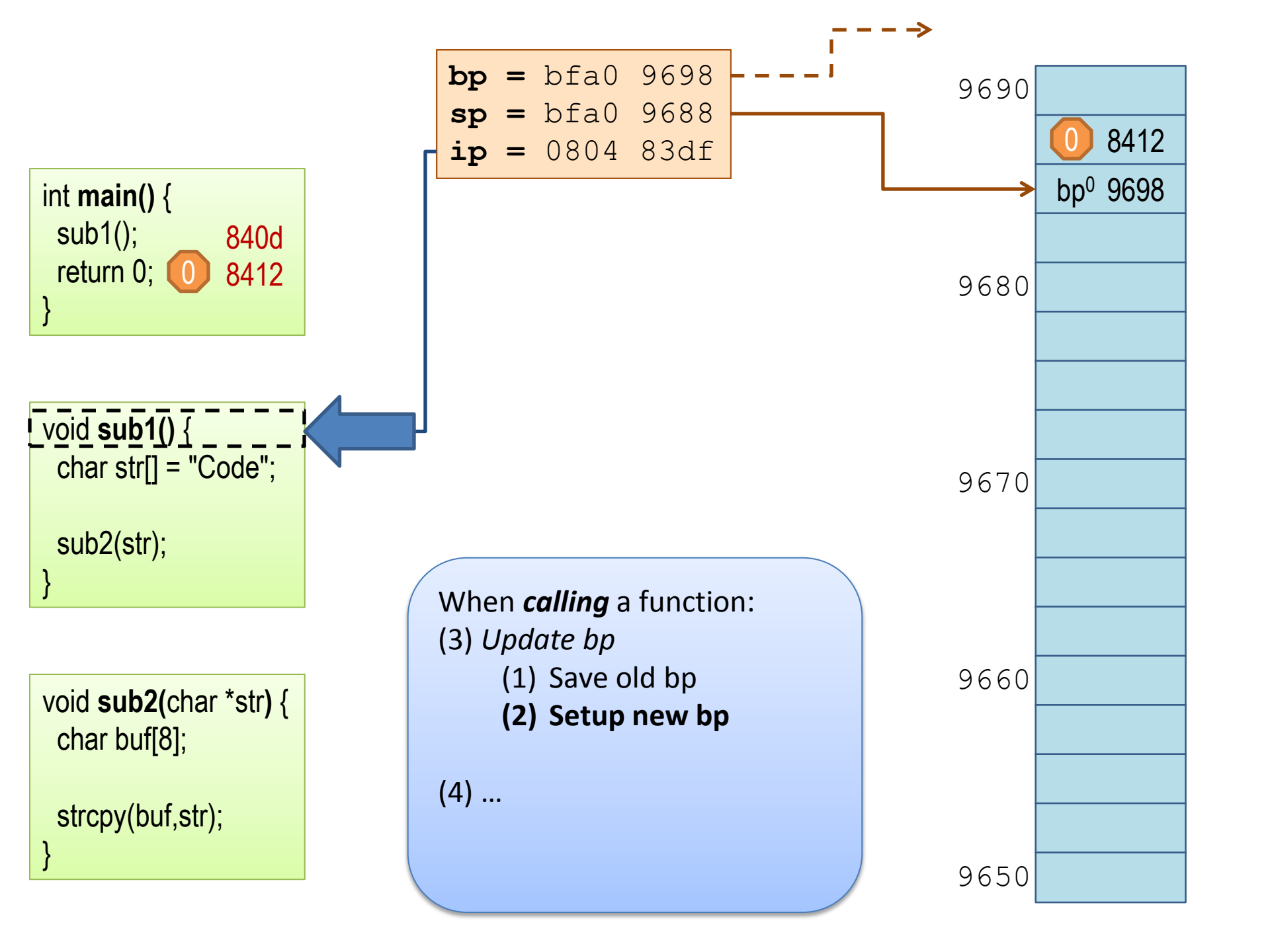

bp = bfa0 9698
sp = bfa0 968c
ip = 0804 840d
9690
0
8412
int main() {
sub1();
840d
return 0;
0
8412
}
void sub1() {
char str[] = "Code";
sub2(str);
}
9670
9660
9650
void sub2(char *str) {
char buf[8];
strcpy(buf,str);
}
When calling a function:
(1) Push ip of next instruction
(1) Next instr address?
(2) Increase sp
(3) Store address
(2) …

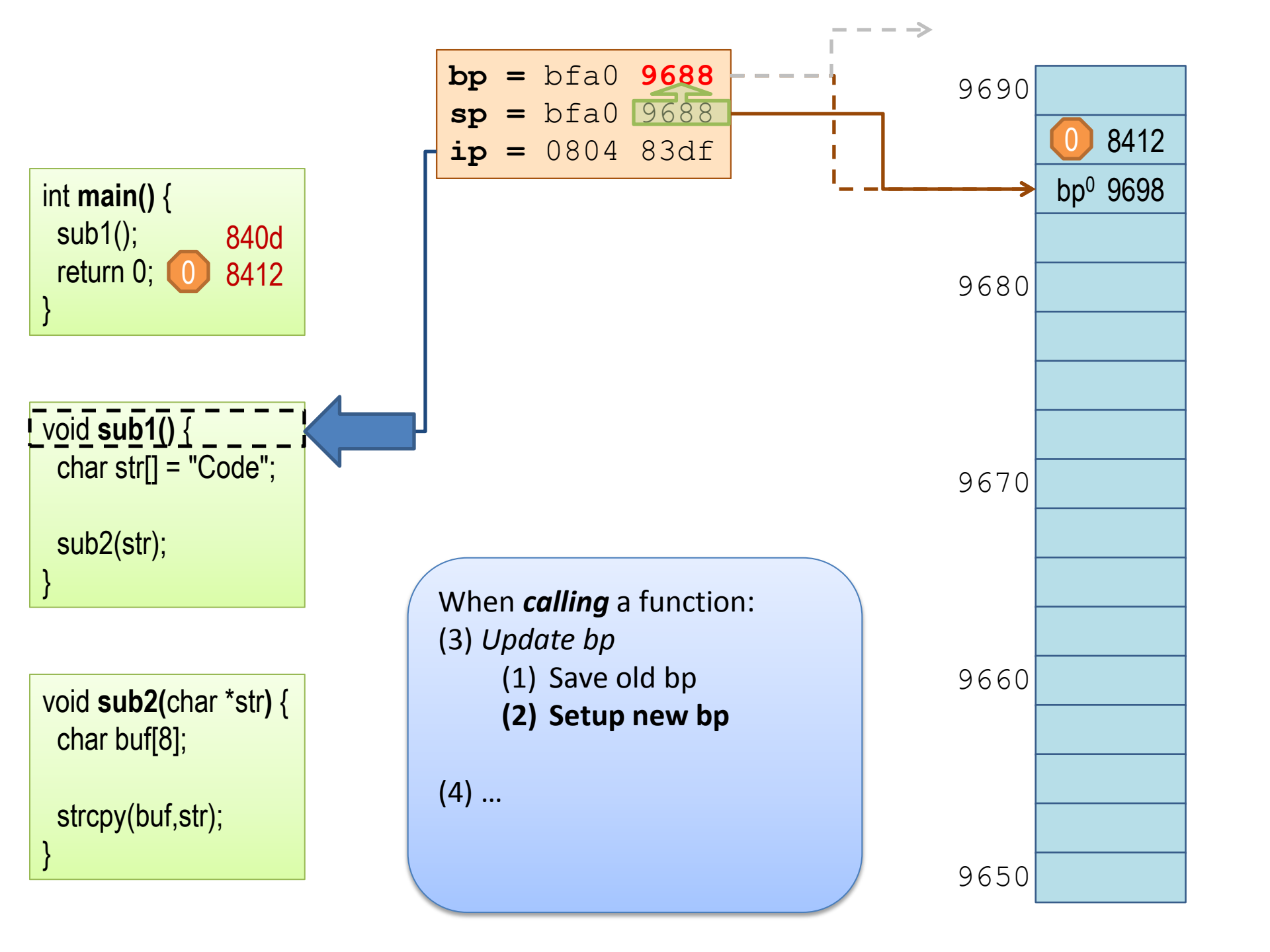

bp = bfa0 9698
sp = bfa0 968c
ip = 0804 840d
int main() {
sub1();
840d
return 0;
0
8412
}
void sub1() {
char str[] = "Code";
sub2(str);
}
void sub2(char *str) {
char buf[8];
strcpy(buf,str);
}
When calling a function:
(0) Setup fcn parameters.
(1) Push ip of next instruction
(2) Jump to new fcn
(3) Update bp
(4) Update sp
(5) Setup local vars.
9690
0
8412
9680
9670
9660
9650

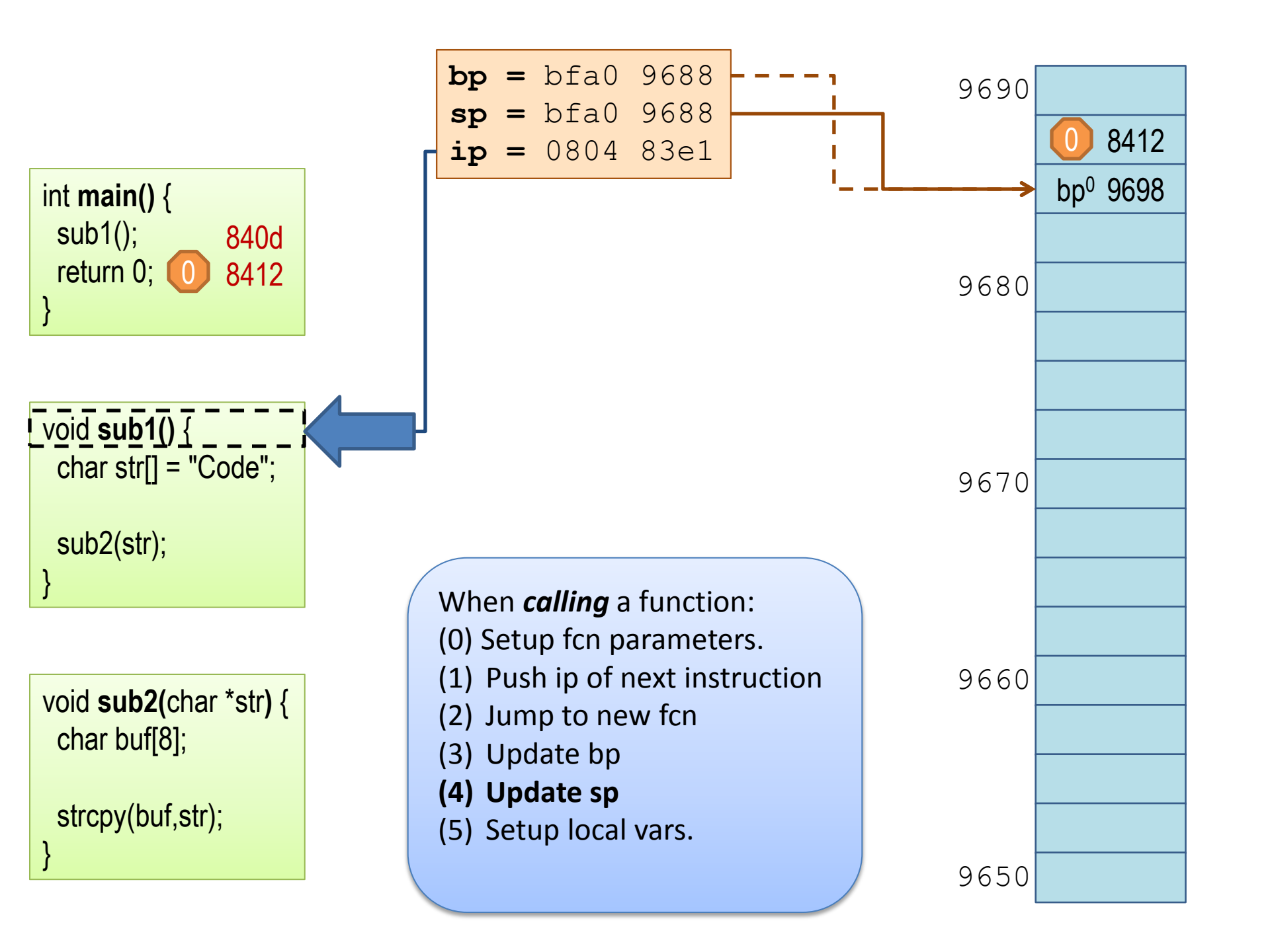

bp = bfa0 9698
sp = bfa0 968c
ip = 0804 83de
9690
9680
9670
9660
9650
0
8412
int main() {
sub1(); 840d
return 0; 0 8412
}
void sub1() {
char str[] = "Code";
sub2(str);
}
void sub2(char *str) {
char buf[8];
strcpy(buf,str);
}
When calling a function:
(0) Setup fcn parameters.
(1) Push ip of next instruction
(2) Jump to new fcn
(3) Update bp
(4) Update sp
(5) Setup local vars.

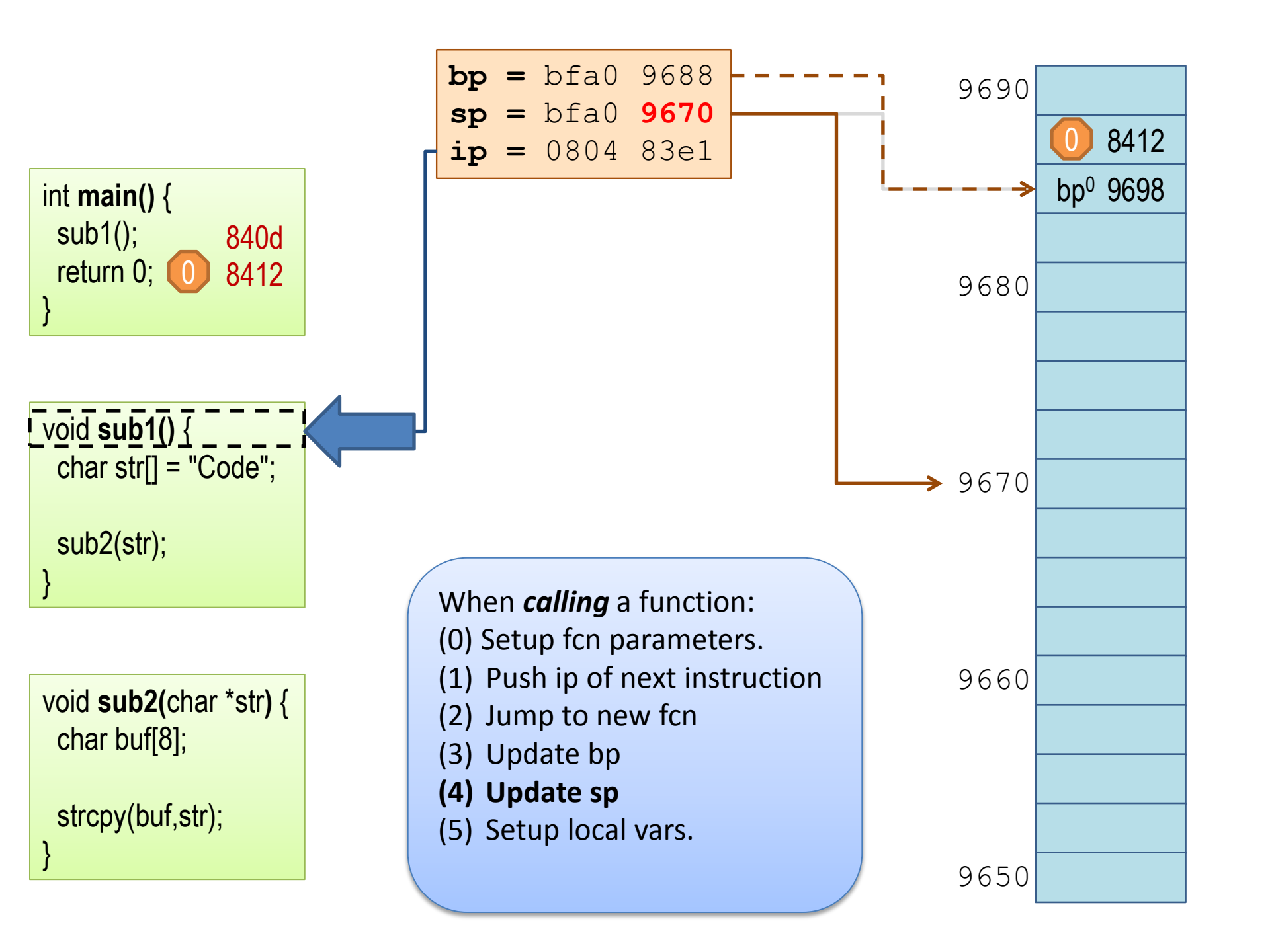

bp = bfa0 9698
sp = bfa0 968c
ip = 0804 83de
int main() {
sub1(); 840d
return 0; 0 8412
}
void sub1() {
char str[] = "Code";
sub2(str);
}
void sub2(char *str) {
char buf[8];
strcpy(buf,str);
}
When calling a function:
(0) Setup fcn parameters.
(1) Push ip of next instruction
(2) Jump to new fcn
(3) Update bp
(4) Update sp
(5) Setup local vars.
9690
0 8412
9680
9670
9660
9650

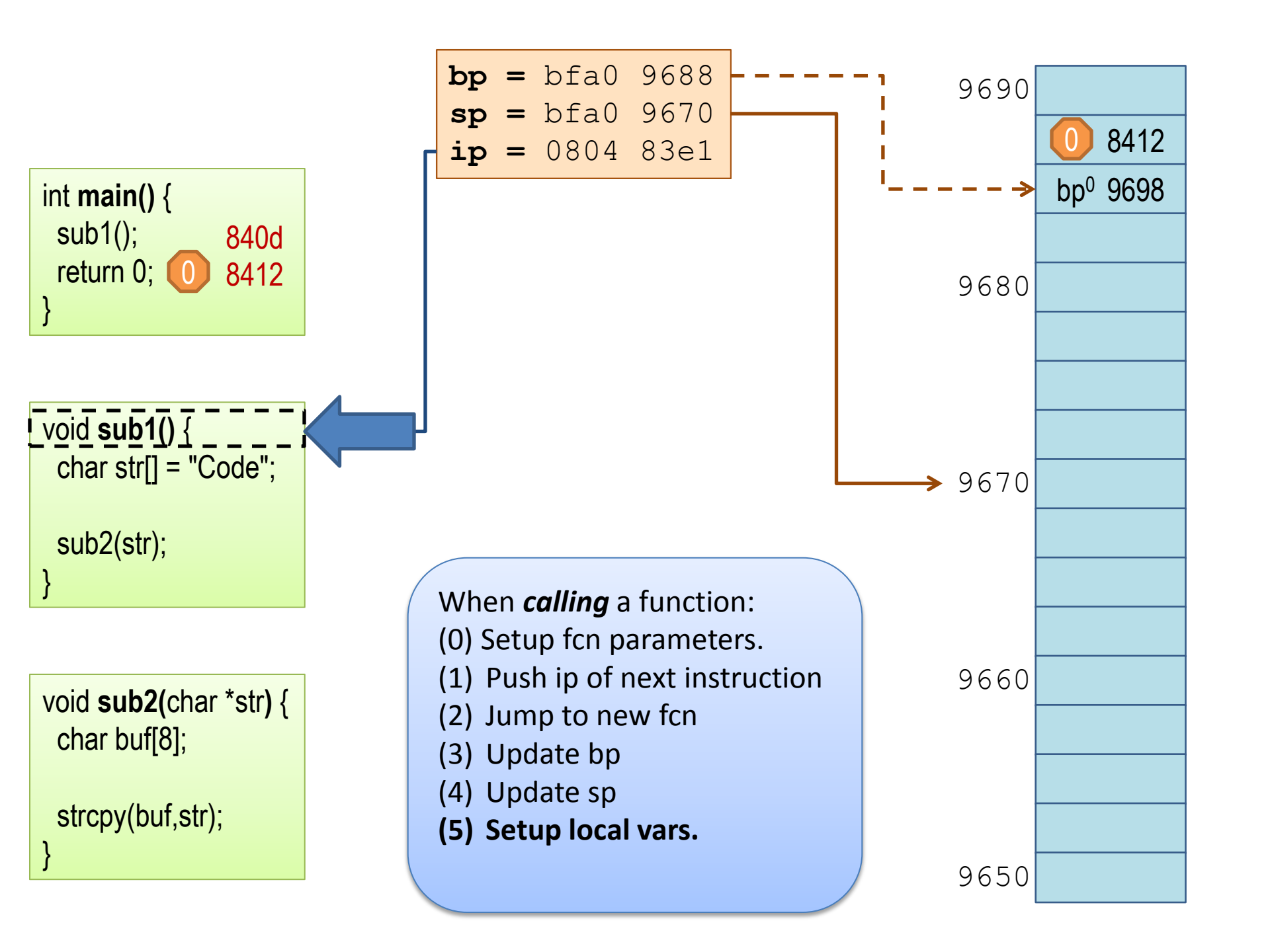

bp = bfa0 9698
sp = bfa0 9688
ip = 0804 83de
int main() {
sub1(); 840d
return 0; 0 8412
}
void sub1() {
char str[] = "Code";
sub2(str);
}
void sub2(char *str) {
char buf[8];
strcpy(buf,str);
}
When calling a function:
(3) Update bp
(1) Save old bp
(2) Setup new bp
(4) ...
0
bp0 9698
9680
9670
9660
9650

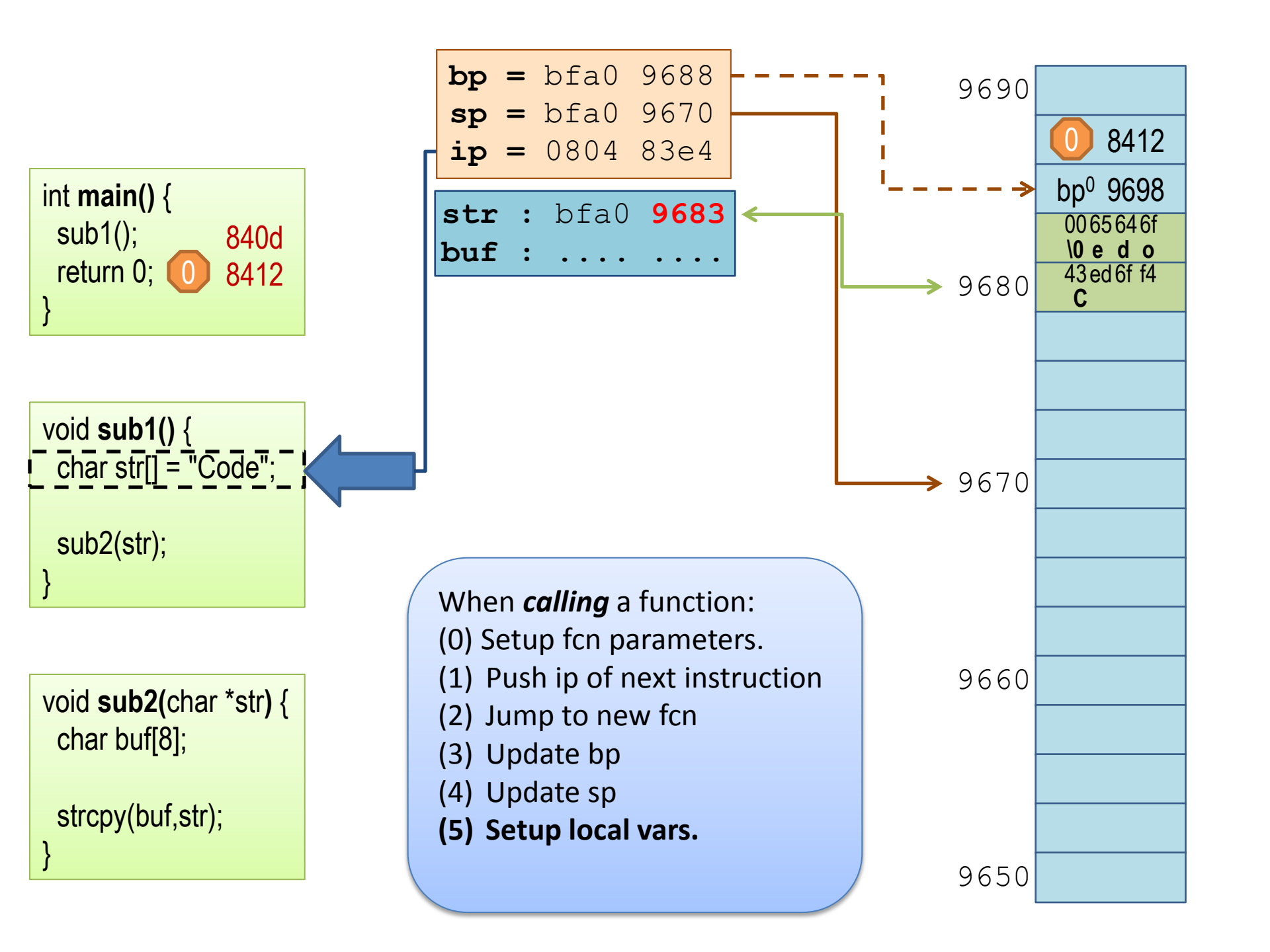

bp = bfa0 9698
sp = bfa0 9688
ip = 0804 83df
9690
0 8412
bp0 9698
9680
9670
9660
9650
int main() {
sub1(); 840d
return 0; 0 8412
}
void sub1() {
char str[] = "Code";
sub2(str);
}
void sub2(char *str) {
char buf[8];
strcpy(buf,str);
}
When calling a function:
(3) Update bp
(1) Save old bp
(2) Setup new bp
(4) ...

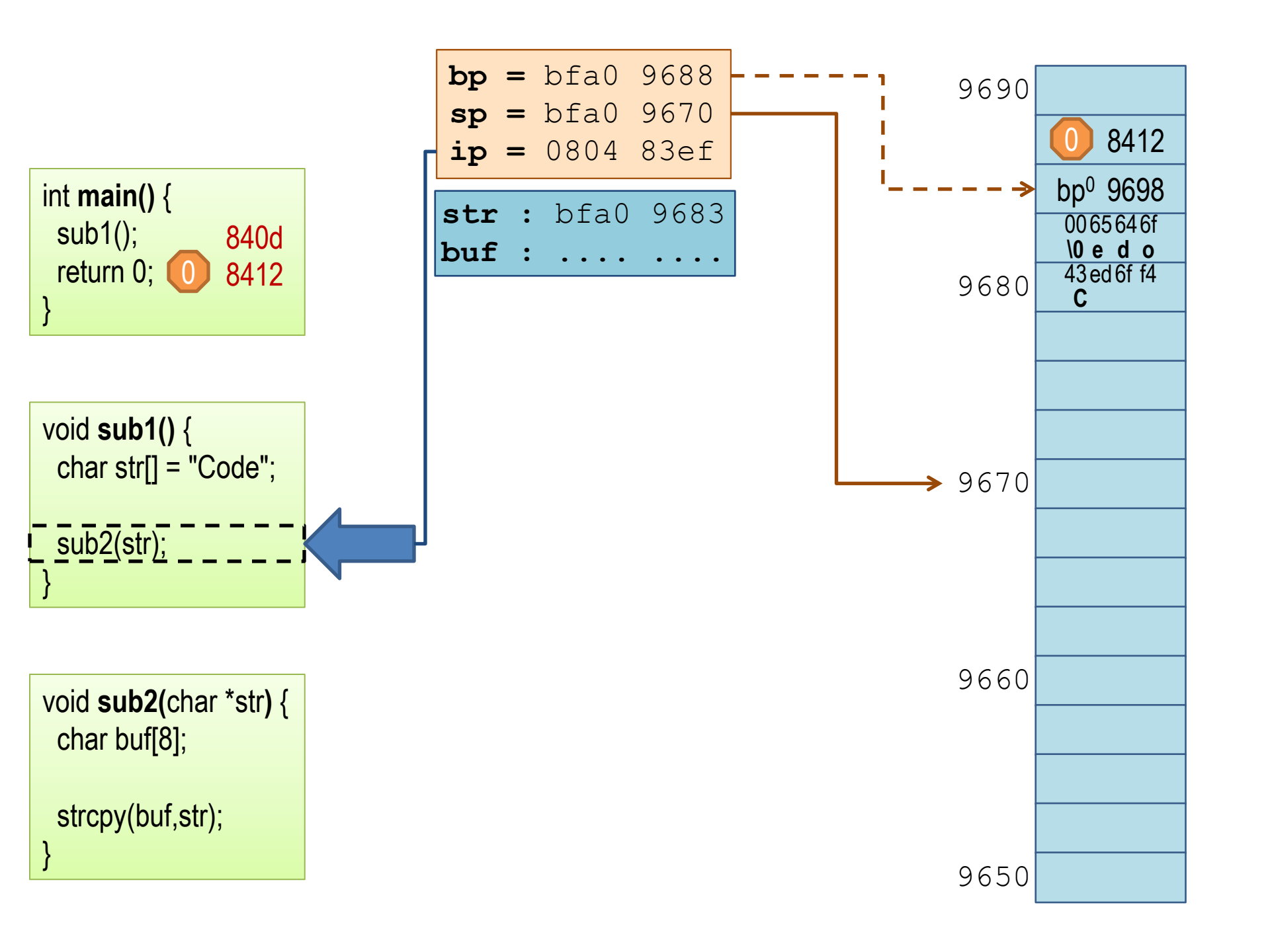

bp = bfa0 9688
sp = bfa0 9688
ip = 0804 83df
int main() {
sub1(); 840d
return 0; 0 8412
}
void sub1() {
char str[] = "Code";
sub2(str);
}
void sub2(char *str) {
char buf[8];
strcpy(buf,str);
}
When calling a function:
(3) Update bp
(1) Save old bp
(2) Setup new bp
(4) ...
9690
0 8412
bp0 9698
9680
9670
9660
9650

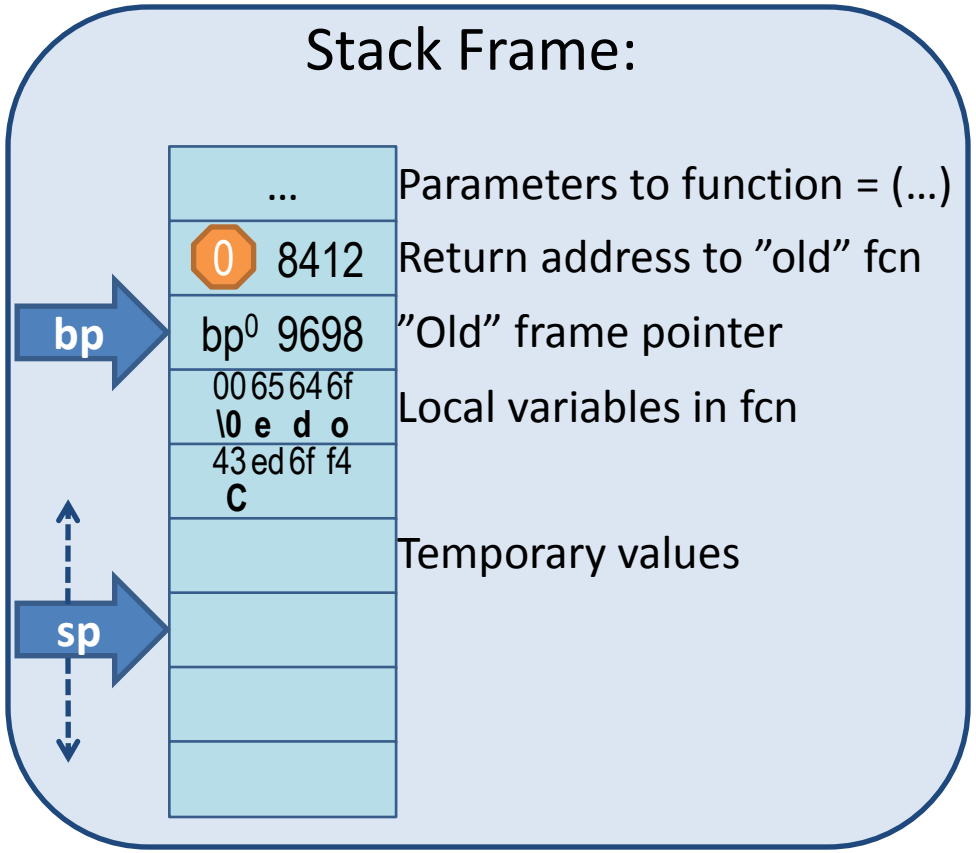

bp = bfa0 9688
sp = bfa0 9688
ip = 0804 83e1
int main() {
sub1(); 840d
return 0; 0 8412
}
void sub1() {
char str[] = "Code";
sub2(str);
}
void sub2(char *str) {
char buf[8];
strcpy(buf,str);
}
When calling a function:
(0) Setup fcn parameters.
(1) Push ip of next instruction
(2) Jump to new fcn
(3) Update bp
(4) Update sp
(5) Setup local vars.
9690
0 8412
bp0 9698
9680
9670
9660
9650

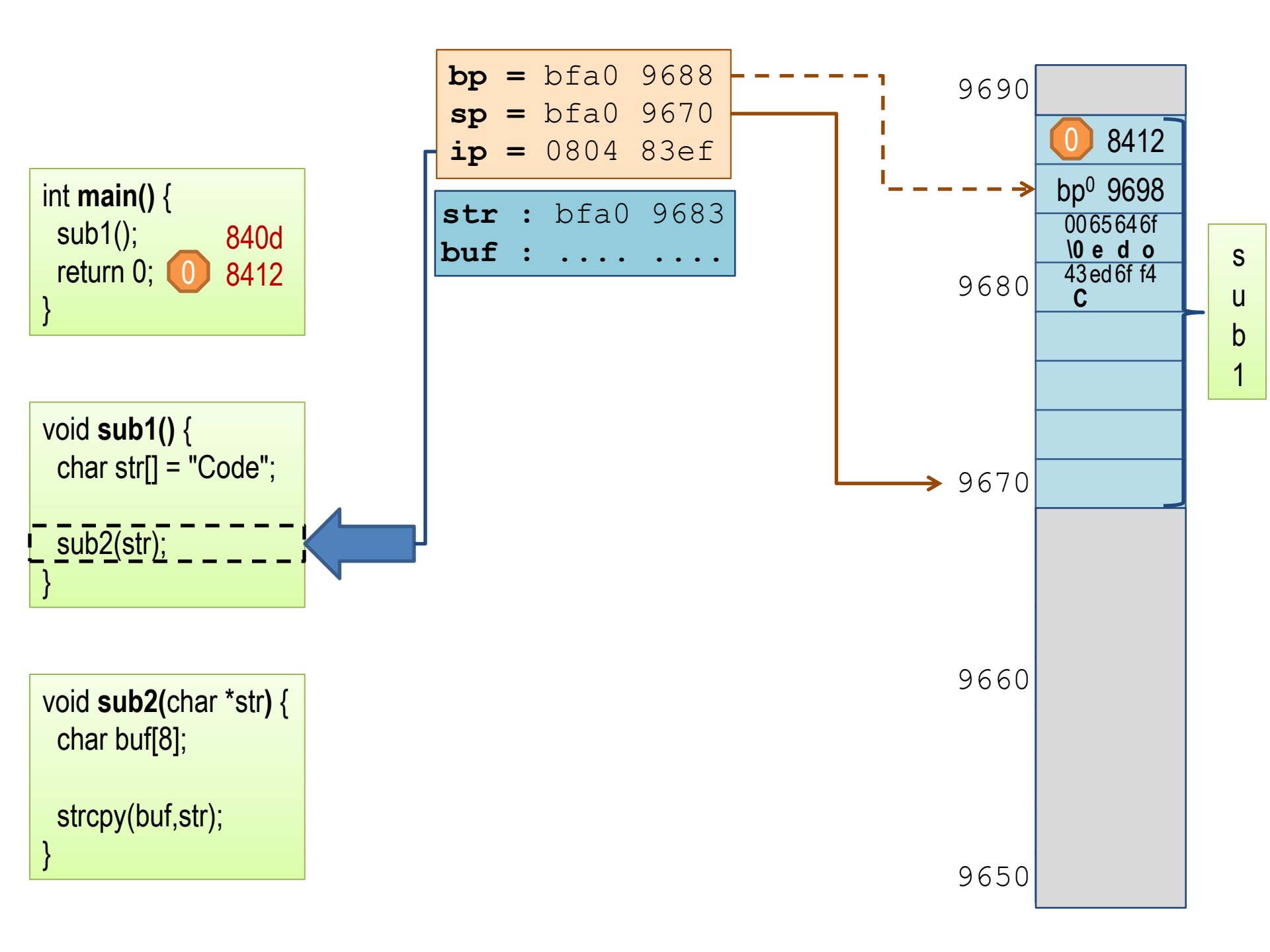

bp = bfa0 9688
sp = bfa0 9670
ip = 0804 83e1
int main() {
sub1(); 840d
return 0; 0 8412
}
void sub1() {
char str[] = "Code";
sub2(str);
}
void sub2(char *str) {
char buf[8];
strcpy(buf,str);
}
When calling a function:
(0) Setup fcn parameters.
(1) Push ip of next instruction
(2) Jump to new fcn
(3) Update bp
(4) Update sp
(5) Setup local vars.
9690
0 8412
bp0 9698
9680
9670
9660
9650

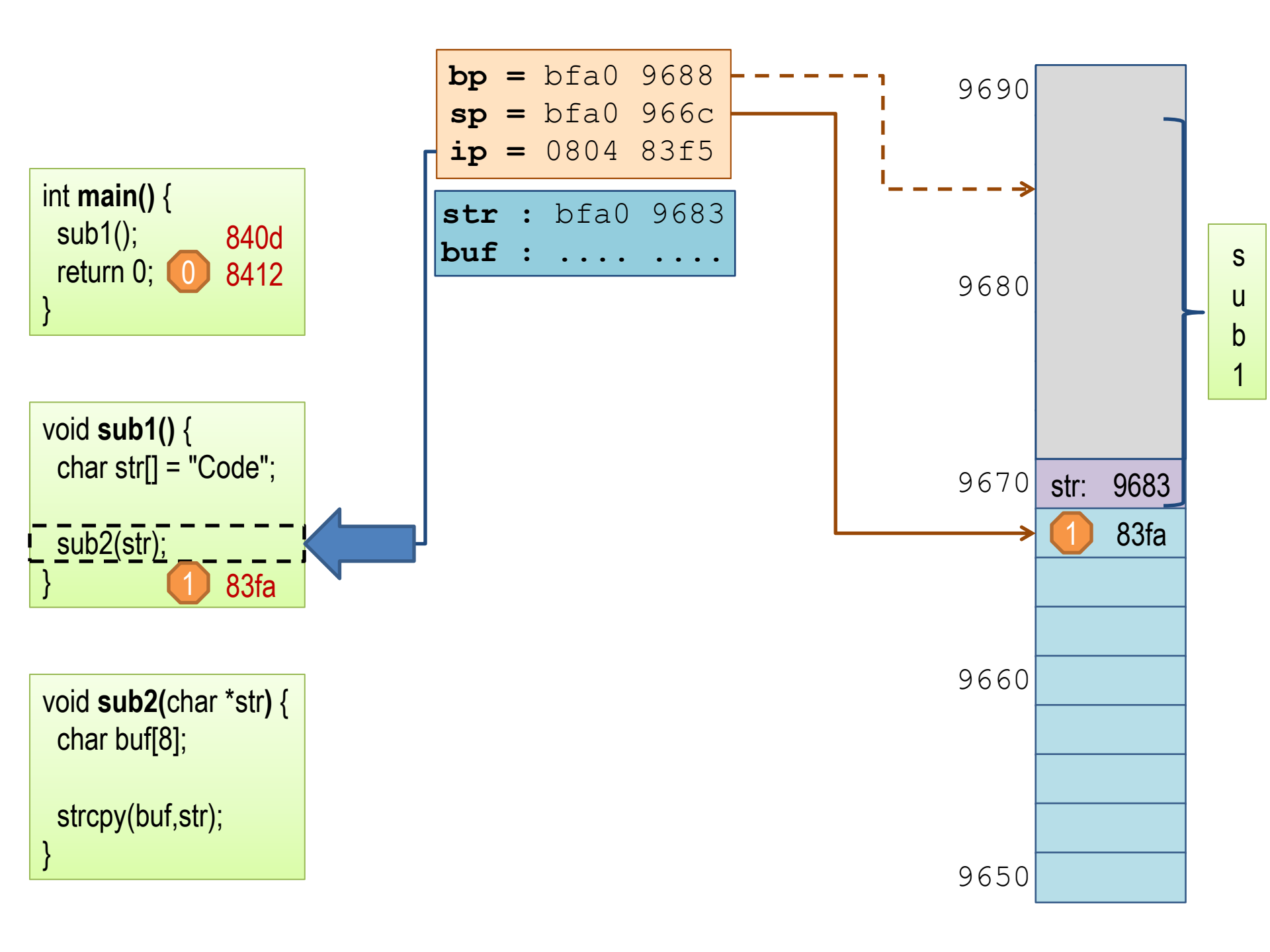

bp = bfa0 9688
sp = bfa0 9670
ip = 0804 83e1
int main() {
sub1(); 840d
return 0; 0 8412
}
void sub1() {
char str[] = "Code";
sub2(str);
}
void sub2(char *str) {
char buf[8];
strcpy(buf,str);
}
When calling a function:
(0) Setup fcn parameters.
(1) Push ip of next instruction
(2) Jump to new fcn
(3) Update bp
(4) Update sp
(5) Setup local vars.
9690
0 8412
bp0 9698
9680
9670
9660
9650

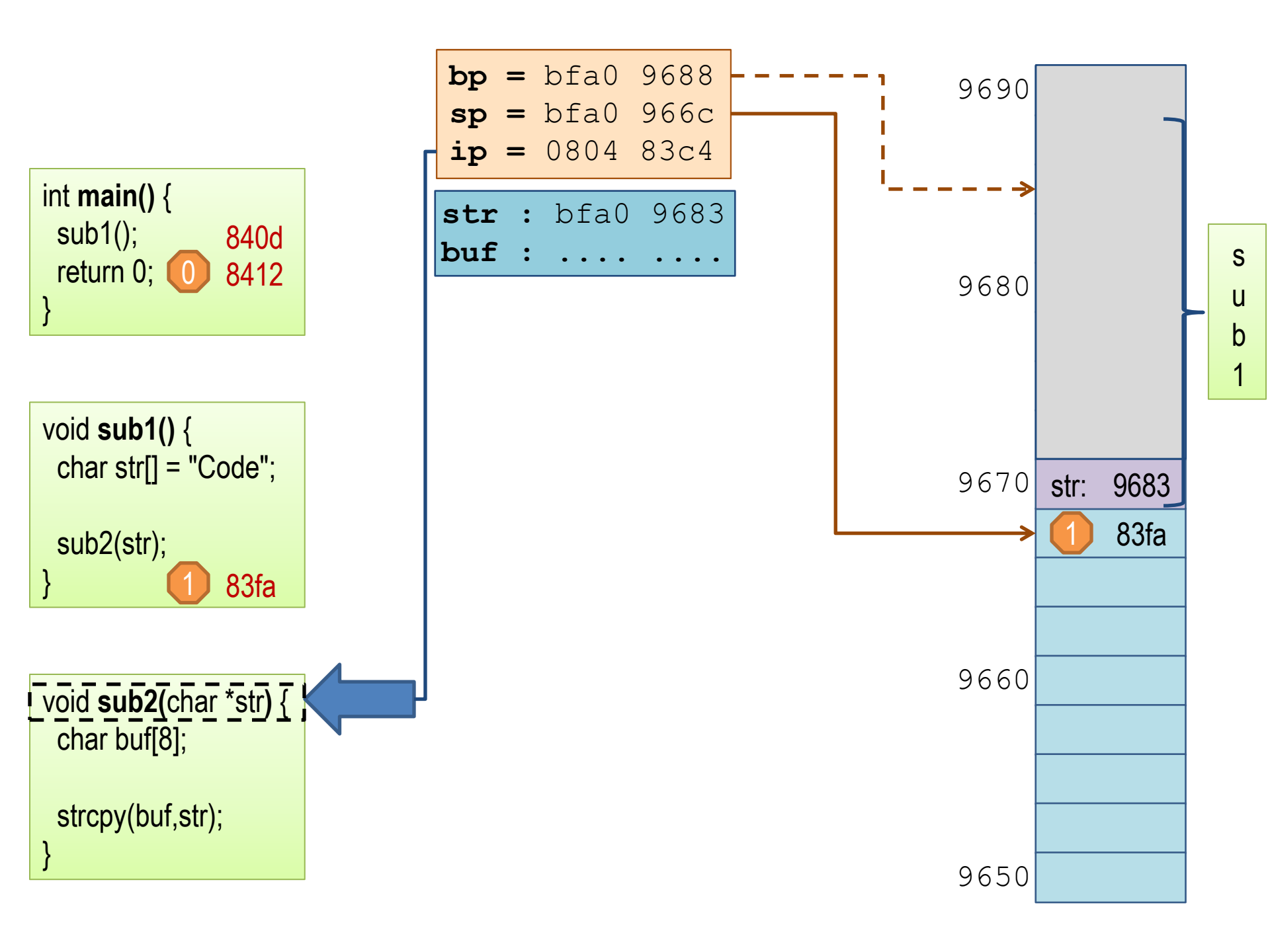

bp = bfa0 9688
sp = bfa0 9670
ip = 0804 83e4
str : bfa0 9683
buf : ....
int main() {
sub1(); 840d
return 0; 0 8412
}
void sub1() {
char str[] = "Code";
sub2(str);
}
void sub2(char *str) {
char buf[8];
strcpy(buf,str);
}
When calling a function:
(0) Setup fcn parameters.
(1) Push ip of next instruction
(2) Jump to new fcn
(3) Update bp
(4) Update sp
(5) Setup local vars.
9690
0 8412
bp0 9698
00 65 64 6f
\0 e d o
43 ed 6f f4
C
9680
9670
9660
9650

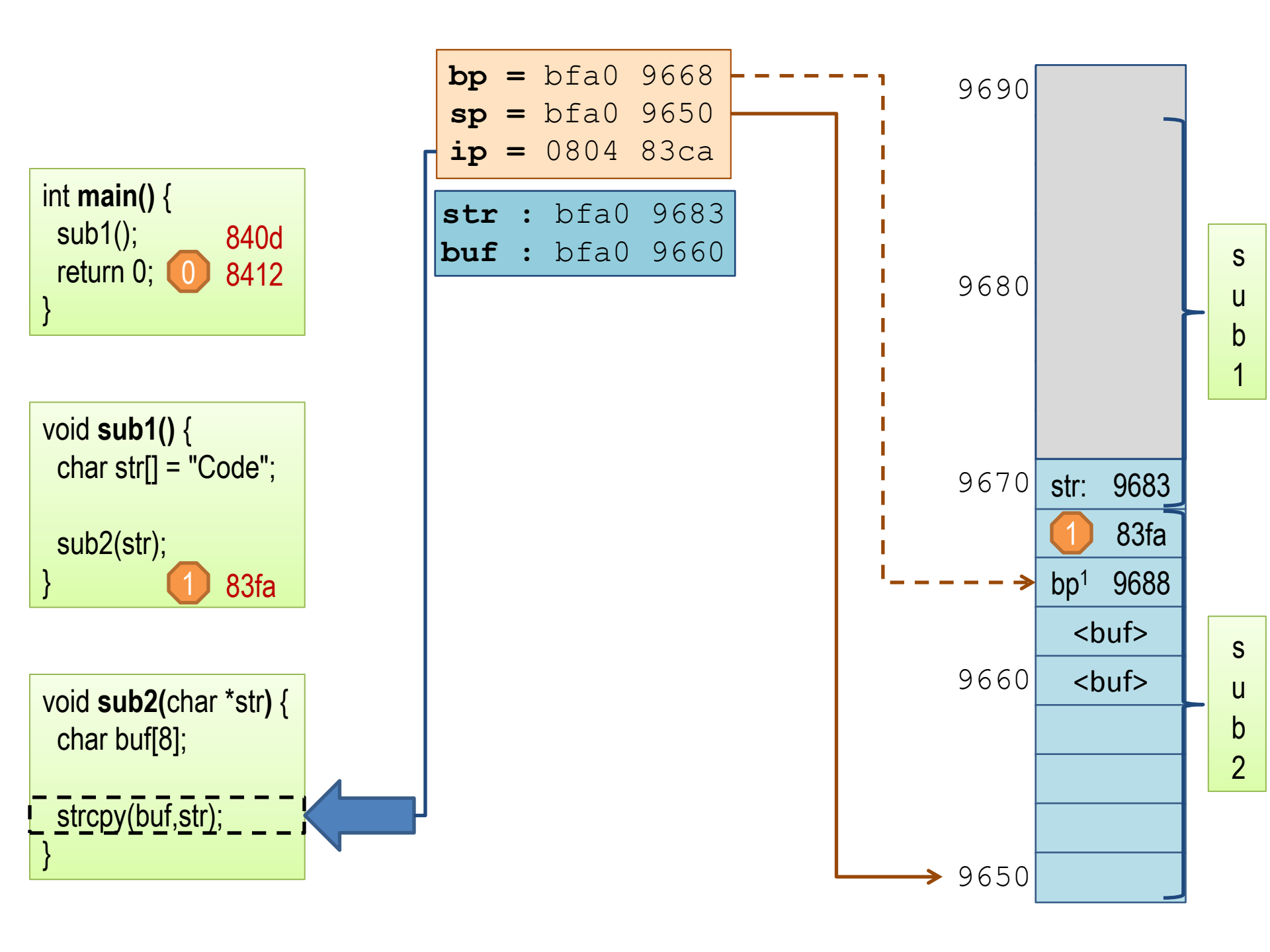

bp = bfa0 9688
sp = bfa0 9670
ip = 0804 83ef
str : bfa0 9683
buf : ....
int main() {
sub1();
840d
return 0;
0
8412
}
void sub1() {
char str[] = "Code";
sub2(str);
}
void sub2(char *str) {
char buf[8];
strcpy(buf,str);
}
9690
0
8412
bp0 9698
00656 46f
\0 e d o
43ed6f f4
C
9680
9670
9660
9650

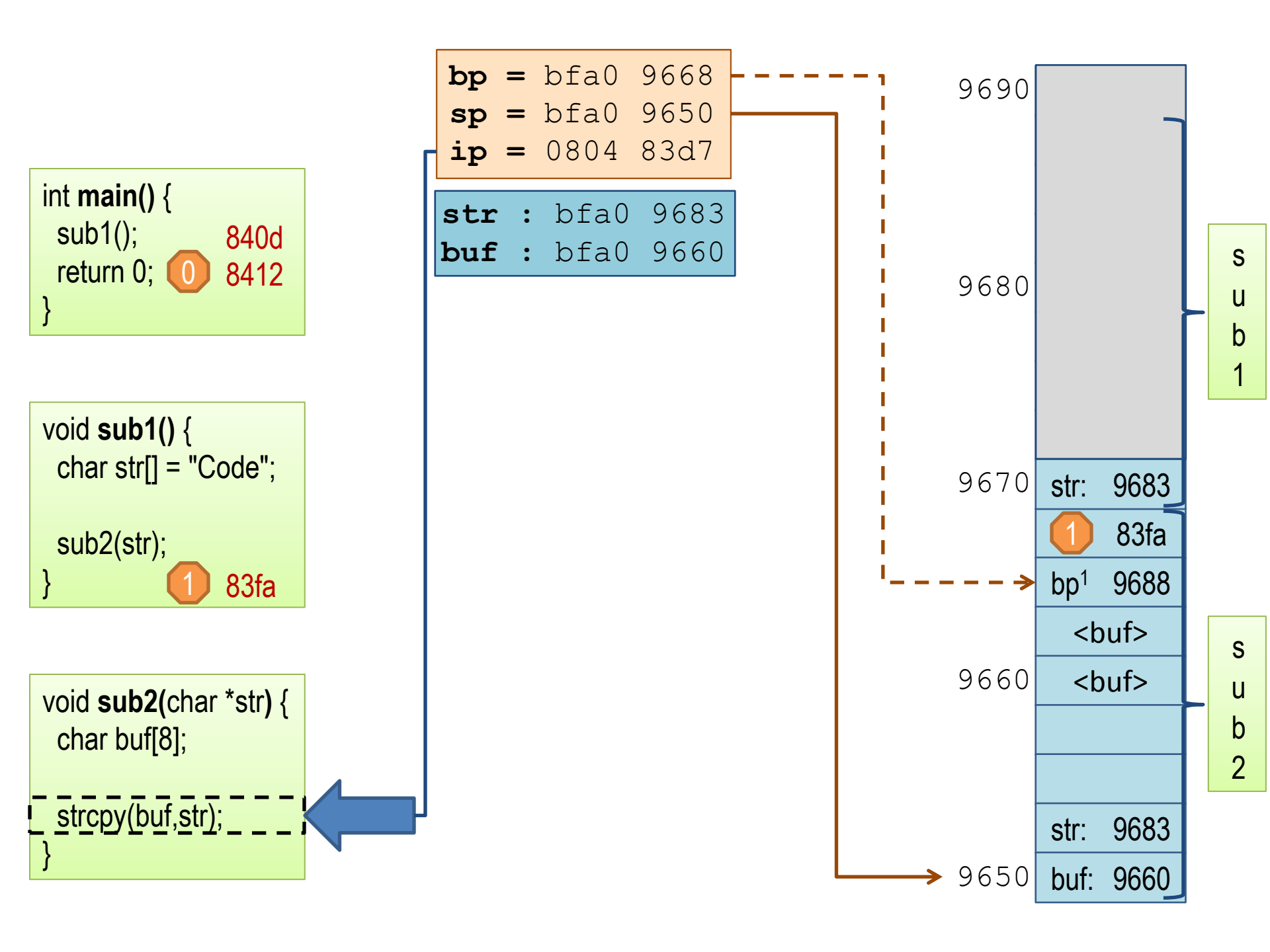

Stack Frame:
...
Parameters to function = (...)
0
8412
Return address to ”old” fcn
bp
bp0 9698
”Old” frame pointer
00 65 64 6f
\0 e d o
Local variables in fcn
43 ed 6f f4
C
Temporary values
sp

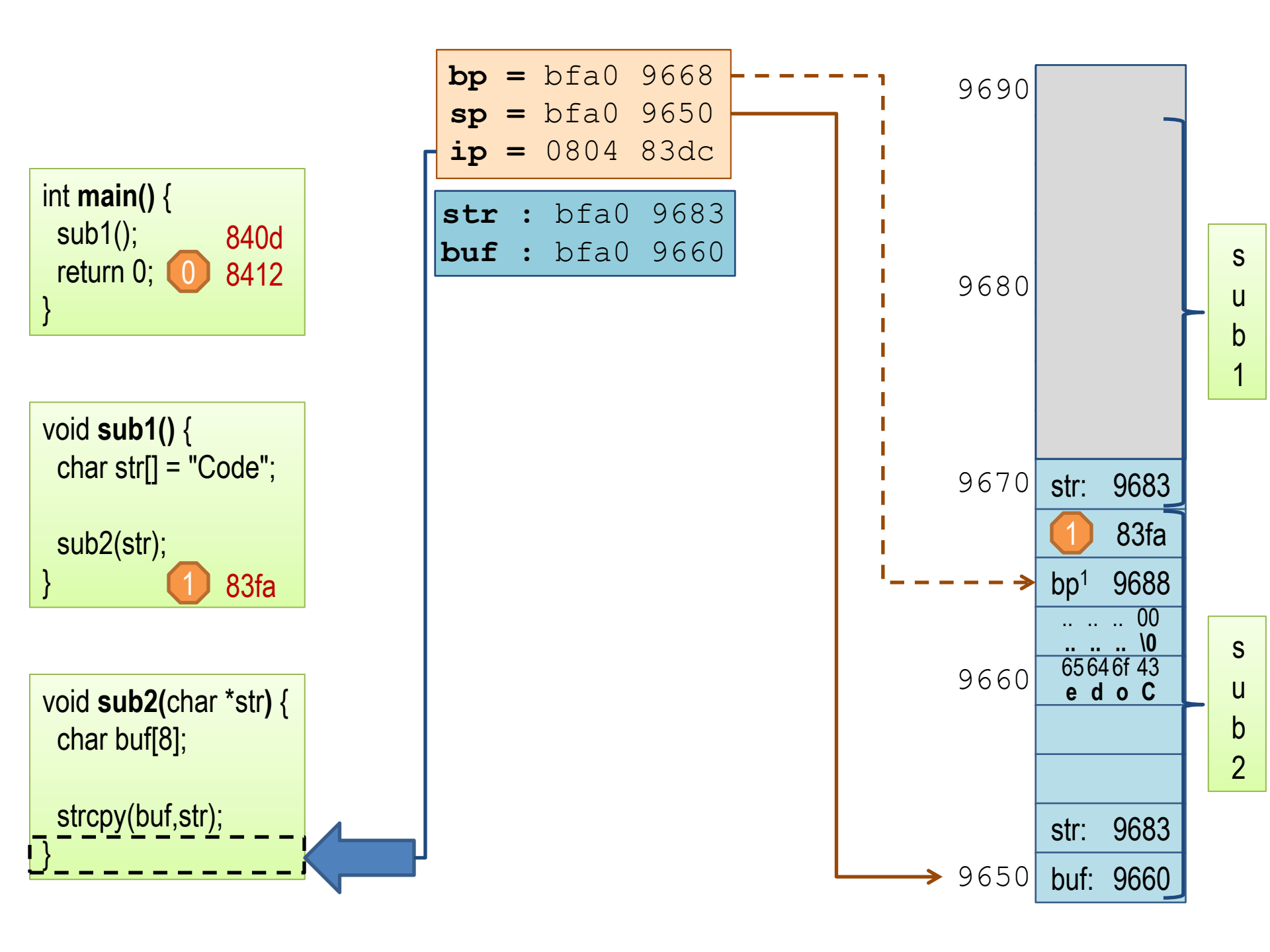

bp = bfa0 9688
sp = bfa0 9670
ip = 0804 83ef
str : bfa0 9683
buf : ....
int main() {
sub1(); 840d
return 0; 0 8412
}
void sub1() {
char str[] = "Code";
sub2(str);
}
void sub2(char *str) {
char buf[8];
strcpy(buf,str);
}
9690
0 8412
bp0 9698
0065646f
\0 e d o
43ed6ff4
C
9680
9670
9660
9650
s
u
b
1


bp = bfa0 9688
sp = bfa0 966c
ip = 0804 83f5
str : bfa0 9683
buf : ....
int main() {
sub1();
840d
return 0;
0
8412
}
void sub1() {
char str[] = "Code";
sub2(str);
}
1
83fa
void sub2(char *str) {
char buf[8];
strcpy(buf,str);
}
9690
9680
9670
9660
9650
str: 9683
1
83fa
s
u
b
1


bp = bfa0 9688
sp = bfa0 966c
ip = 0804 83c4
str : bfa0 9683
buf : ....
int main() {
sub1();
840d
return 0;
0
8412
}
void sub1() {
char str[] = "Code";
sub2(str);
}
1
83fa
void sub2(char *str) {
char buf[8];
strcpy(buf,str);
}
9690
9680
9670
9660
9650
str: 9683
1
83fa
sub1

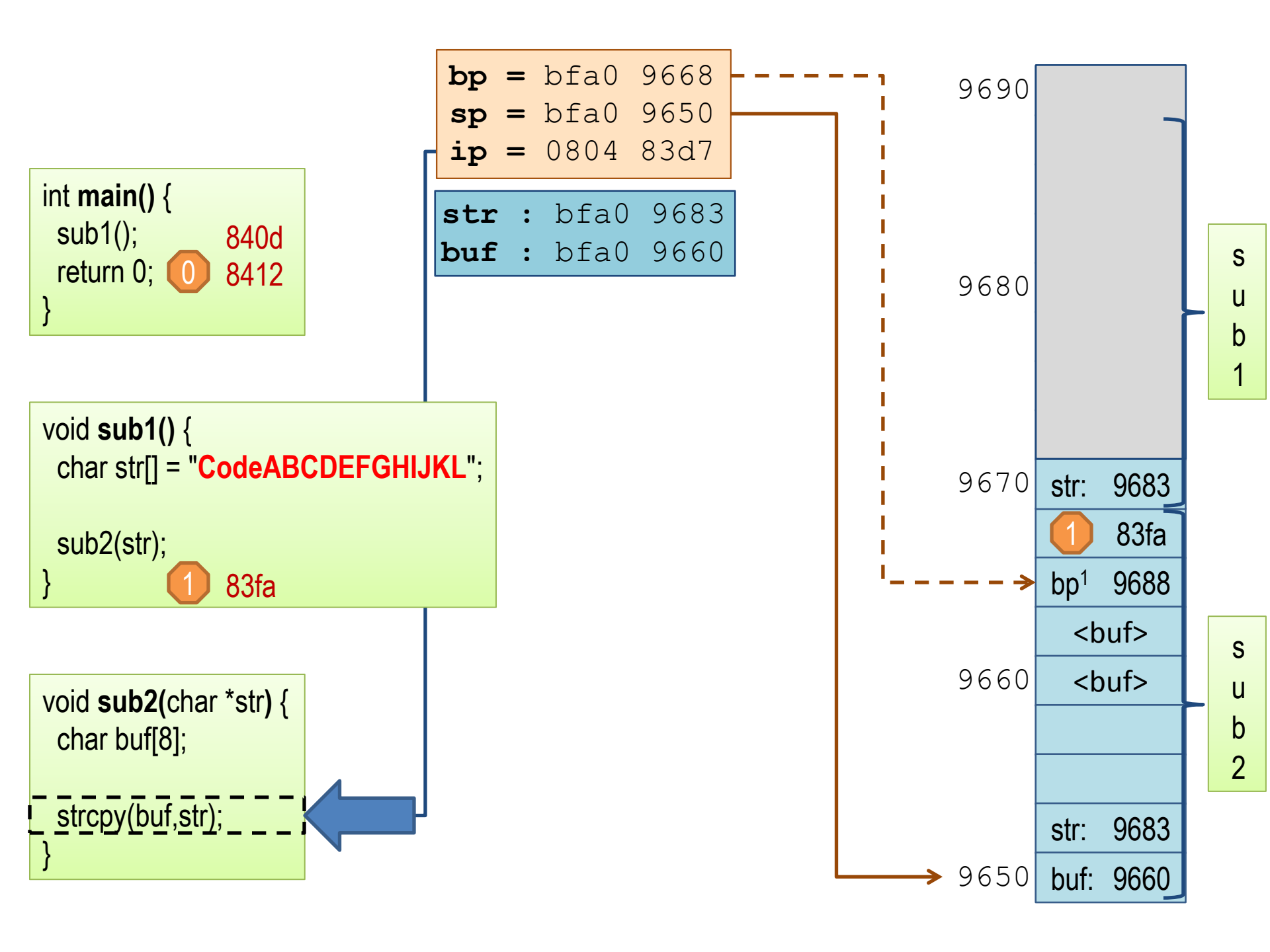

bp = bfa0 9668
sp = bfa0 9650
ip = 0804 83ca
str : bfa0 9683
buf : bfa0 9660
int main() {
sub1(); 840d
return 0; 0 8412
}
void sub1() {
char str[] = "Code";
sub2(str);
} 1 83fa
void sub2(char *str) {
char buf[8];
strcpy(buf,str);
}
9690
9680
9670
9660
9650
str: 9683
1 83fa
bp1 9688
<buf>
<buf>
sub1
sub2

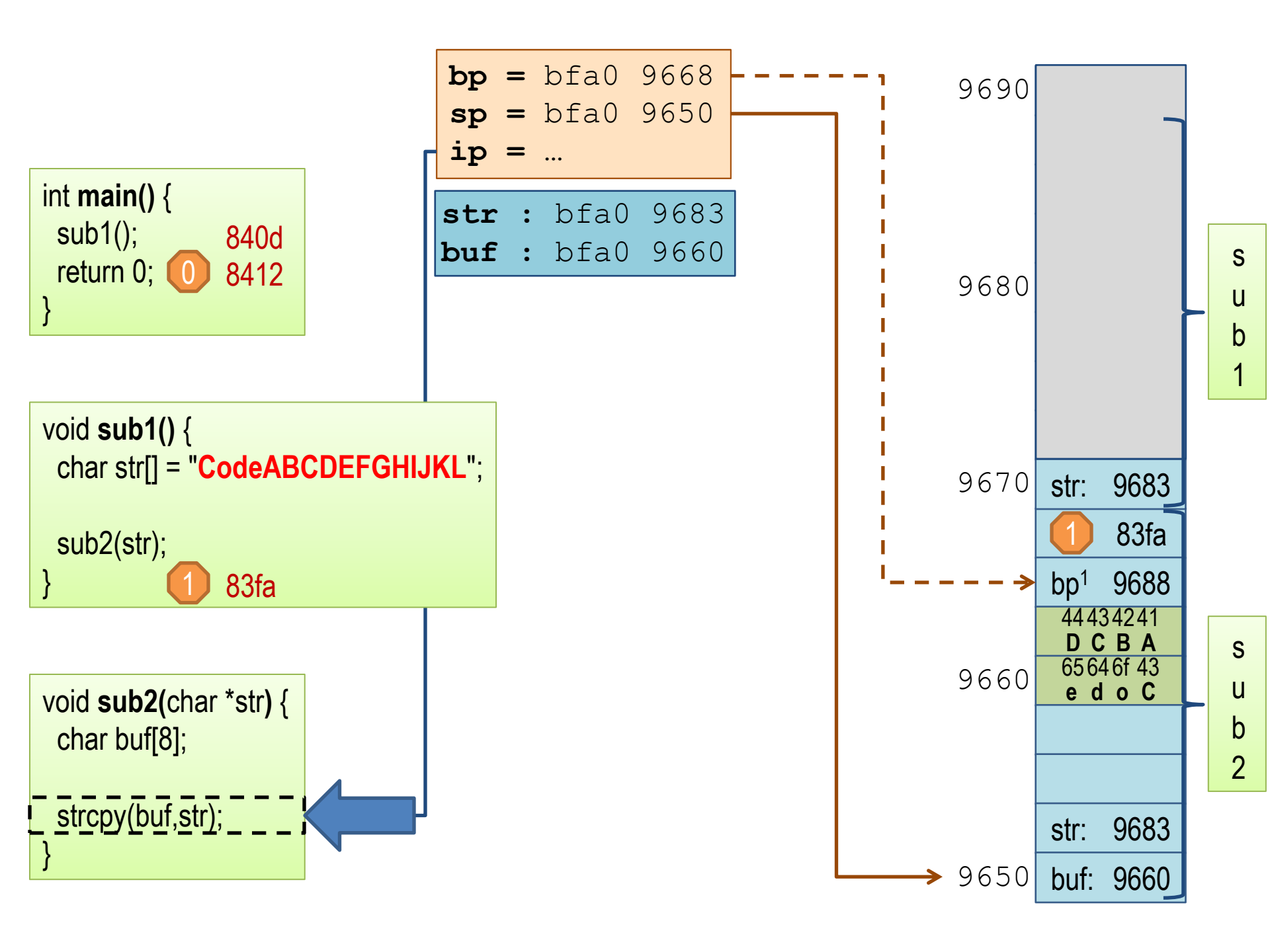

bp = bfa0 9668
sp = bfa0 9650
ip = 0804 83d7
str : bfa0 9683
buf : bfa0 9660
int main() {
sub1(); 840d
return 0; 0 8412
}
void sub1() {
char str[] = "Code";
sub2(str);
} 1 83fa
void sub2(char *str) {
char buf[8];
strcpy(buf,str);
}
9690
9680
9670
9660
9650
str: 9683
1 83fa
bp1 9688
<buf>
<buf>
str: 9683
buf: 9660
sub1
sub2

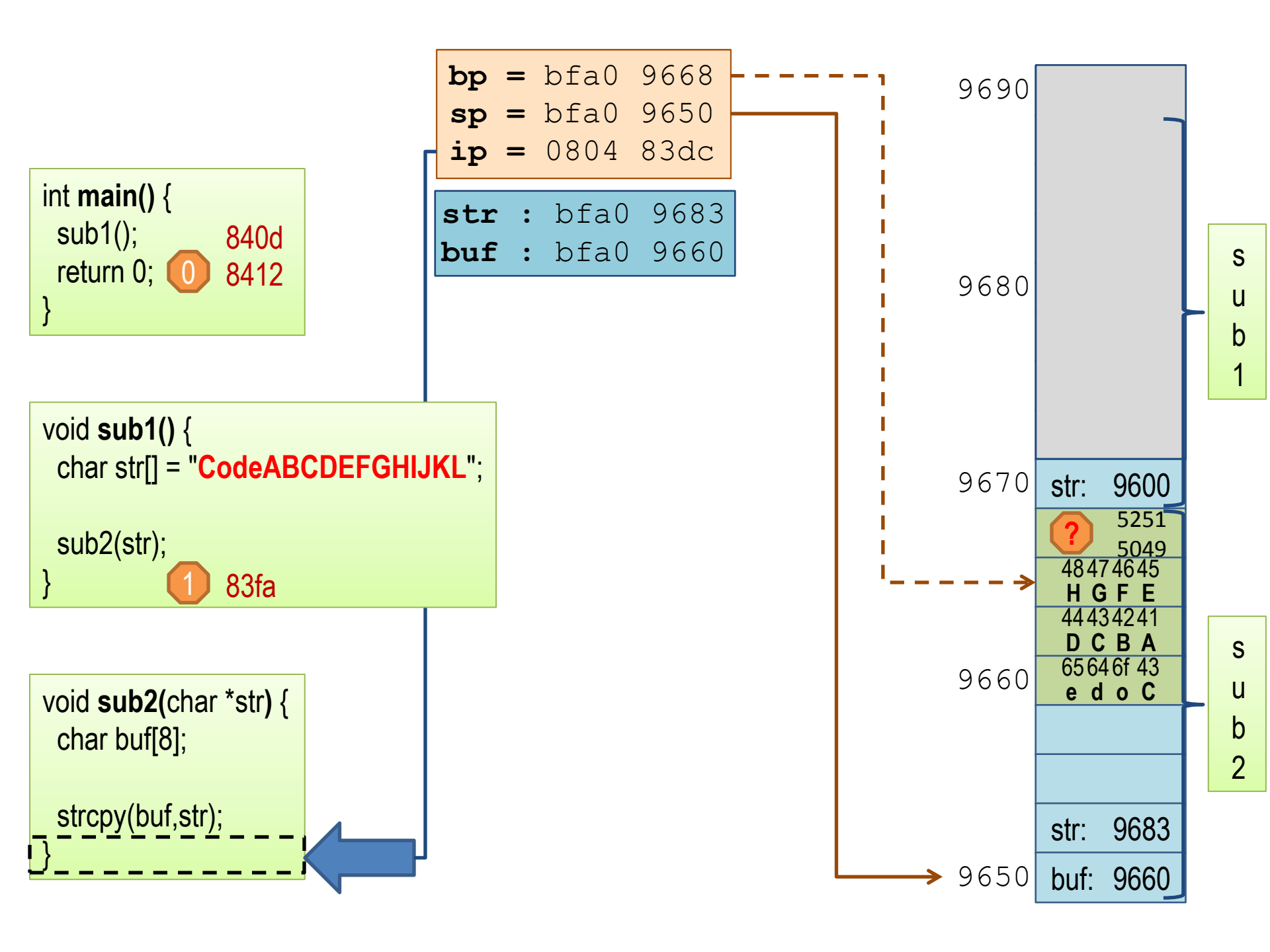

bp = bfa0 9668
sp = bfa0 9650
ip = 0804 83dc
str : bfa0 9683
buf : bfa0 9660
int main() {
sub1(); 840d
return 0; 0 8412
}
void sub1() {
char str[] = "Code";
sub2(str);
} 1 83fa
void sub2(char *str) {
char buf[8];
strcpy(buf,str);
}
9690
9680
9670
9660
9650
str: 9683
1 83fa
bp1 9688
.. 00
.. .. .. \0
65 64 6f 43
e d o C
str: 9683
buf: 9660
sub1
sub2

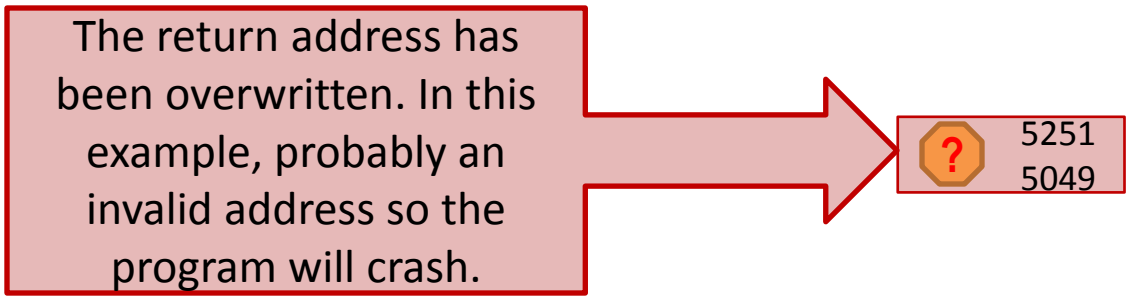
What if the string **`str`** was longer
than 5 characters?
(4 characters + ending ’\0’-character)

Let’s back up a few steps …


bp = bfa0 9668
sp = bfa0 9650
ip = 0804 83d7
str : bfa0 9683
buf : bfa0 9660
int main() {
sub1(); 840d
return 0; 0 8412
}
void sub1() {
char str[] = "CodeABCDEFGHIJKL";
sub2(str);
} 1 83fa
void sub2(char *str) {
char buf[8];
strcpy(buf,str);
}
9690
9680
9670
9660
9650
str: 9683
1 83fa
bp1 9688
<buf>
<buf>
str: 9683
buf: 9660
sub1
sub2


bp = bfa0 9668
sp = bfa0 9650
ip = …
str : bfa0 9683
buf : bfa0 9660
int main() {
sub1(); 840d
return 0; 0 8412
}
void sub1() {
char str[] = "CodeABCDEFGHIJKL";
sub2(str);
} 1 83fa
void sub2(char *str) {
char buf[8];
strcpy(buf,str);
}
9690
9680
9670
9660
9650
str: 9683
1 83fa
bp1 9688
44434241
D C B A
65646f 43
e d o C
str: 9683
buf: 9660
sub1
sub2


bp = bfa0 9668
sp = bfa0 9650
ip = 0804 83dc
str : bfa0 9683
buf : bfa0 9660
int main() {
sub1(); 840d
return 0; 0 8412
}
void sub1() {
char str[] = "CodeABCDEFGHIJKL";
sub2(str);
} 1 83fa
void sub2(char *str) {
char buf[8];
strcpy(buf,str);
}
9690
9680
9670
9660
9650
str: 9600
?
5251
5049
48474645
H G F E
44434241
D C B A
65646f 43
e d o C
str: 9683
buf: 9660
sub1
sub2


The return address has been overwritten. In this example, probably an invalid address so the program will crash.
?
5251
5049

Trick: Jump back ***into*** your buffer