Buffer Overflow Attacks

1. Smashing the Stack
2. Other Buffer Overflow Attacks
3. Work on Preventing Buffer Overflow Attacks

Smashing the Stack

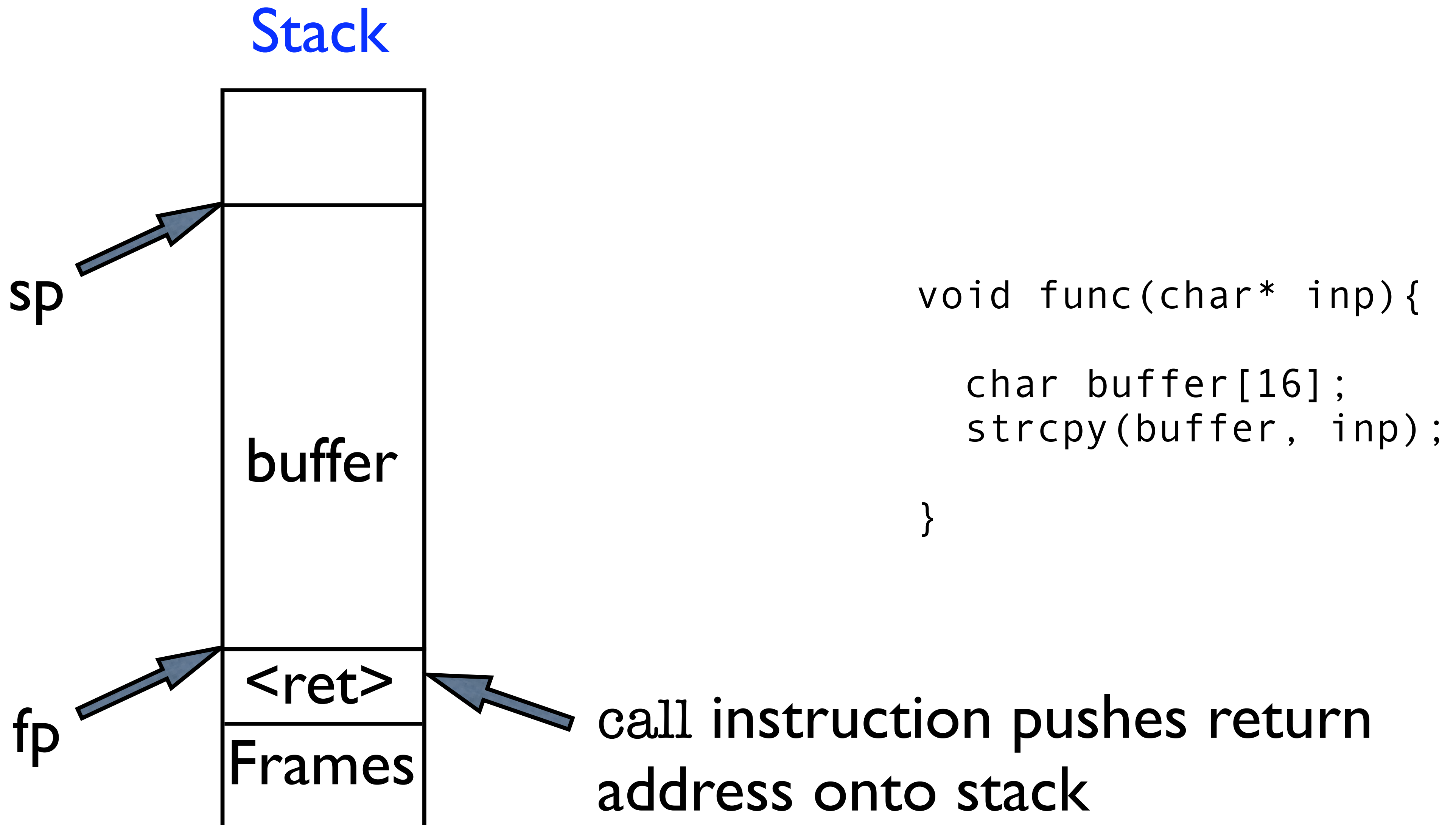
An Evil Function

```
void func(char* inp){

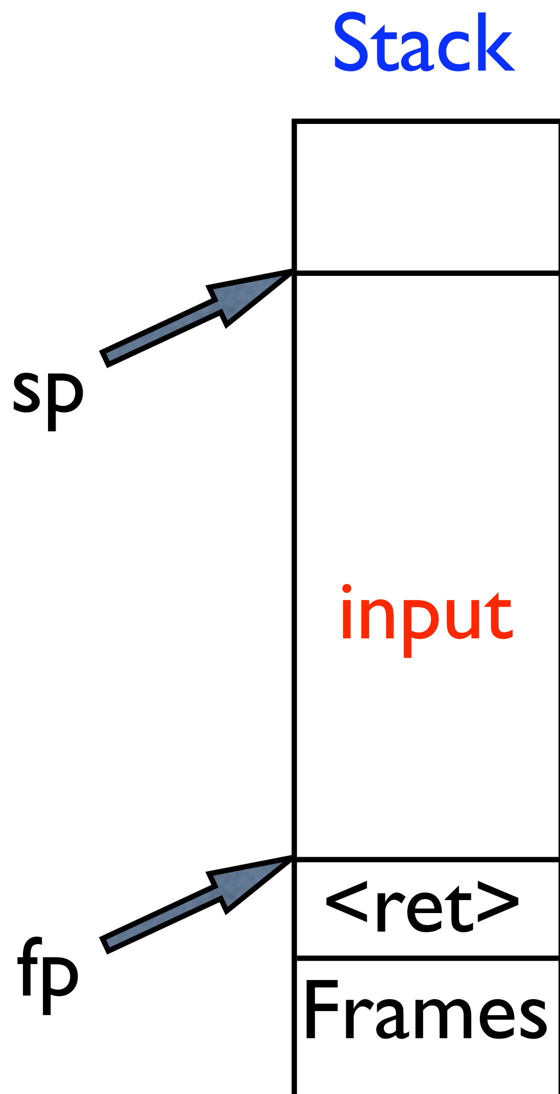
    char buffer[16];
    strcpy(buffer, inp);

}
```

Calling `func`



Operation of `func`




```
void func(char* inp){

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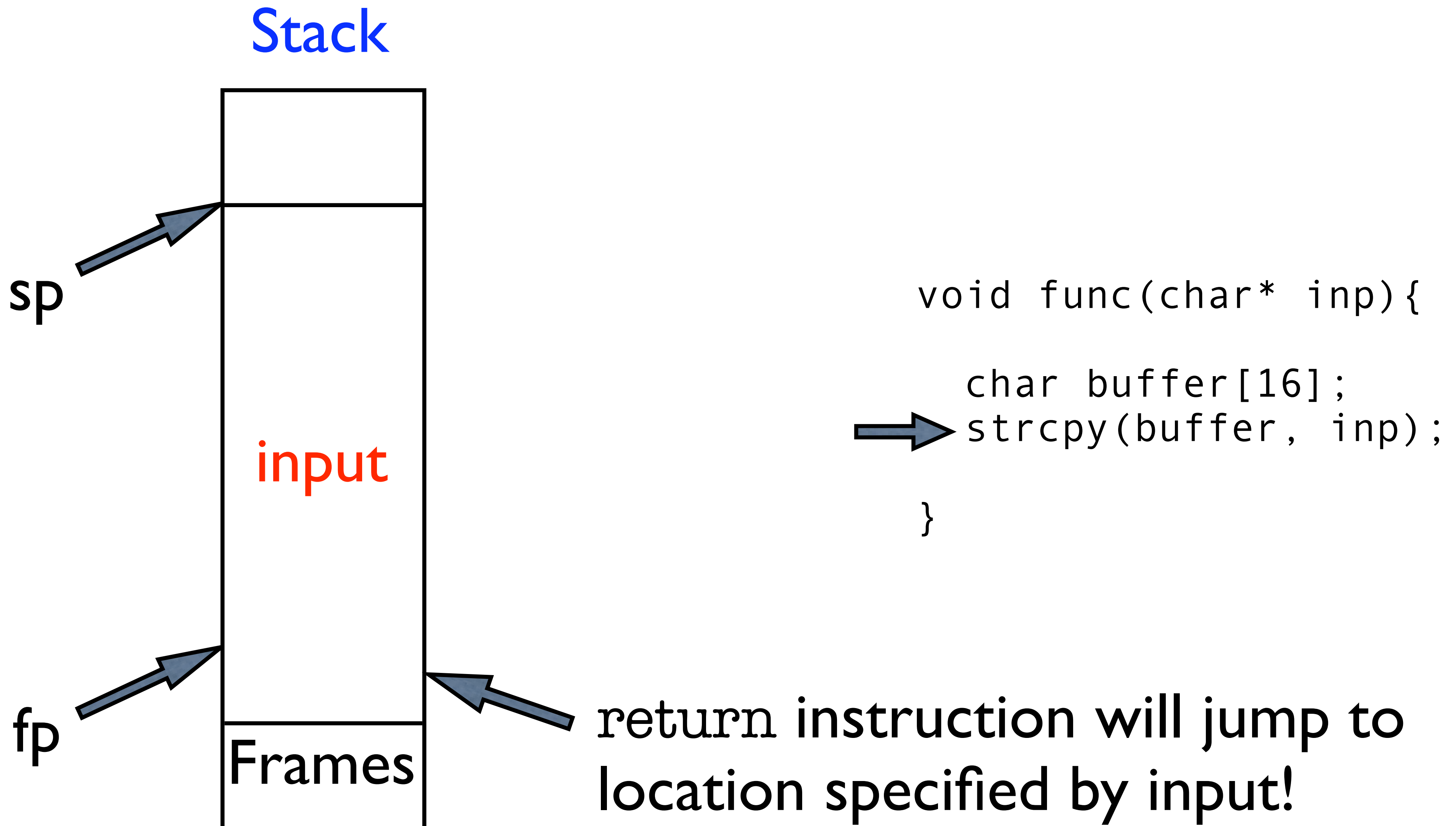
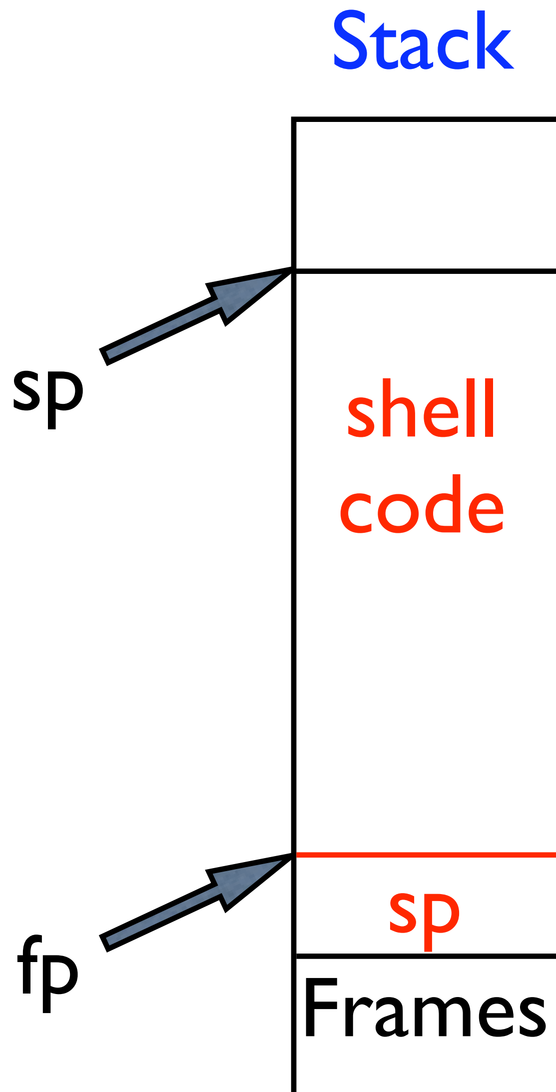
  strcpy(buffer, inp);

}
```

C doesn't check bounds...



The Exploit

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  char buffer[16];
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}
```

Two Questions

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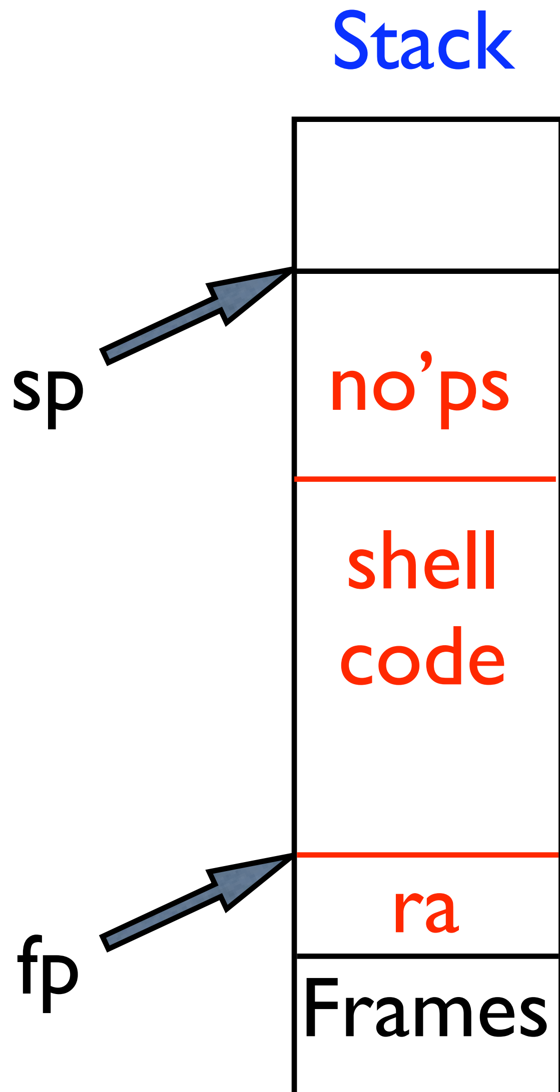
Answer: she doesn't, but she can guess...

Guessing ra

- Stack has same starting location in all programs
- Most programs don't ever put more than a few thousand bytes on the stack
- So, just guess ra!

Adding a "Launching Pad"




```
void func(char* inp){

  char buffer[16];
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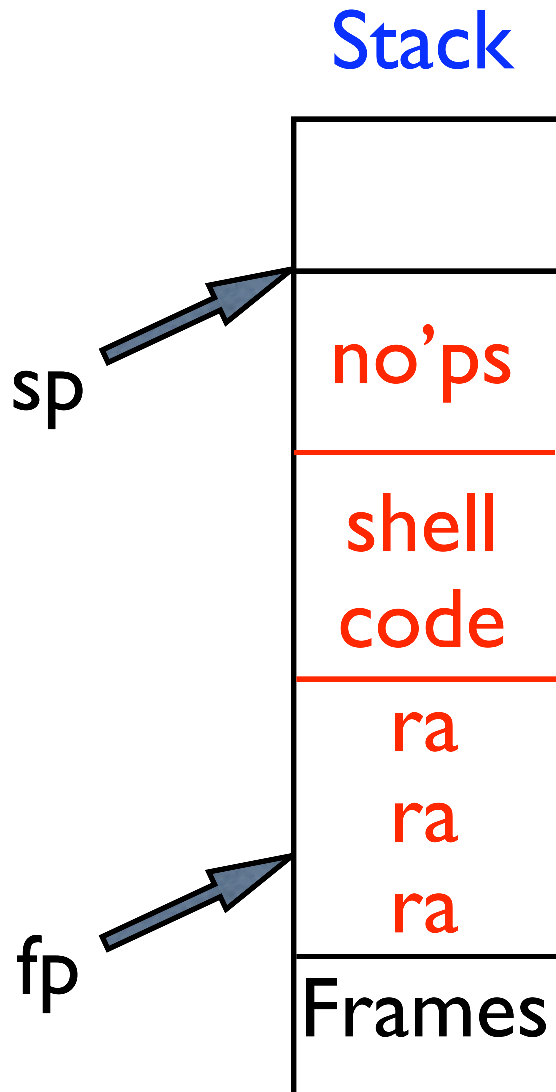
}
```

Guessing Where to Put ra in the Input

- This is really just trial-and-error...
- But we can improve our chances on this as well.

Improvement




```
void func(char* inp){

  char buffer[16];
  strcpy(buffer, inp);

}
```

Final Version of Input

no'ps	shellcode	ra ra ra

A good value of ra is worked out through trial and error, as is a good length for the input

Other Buffer Overflow Attacks

Arc Injection

- Input overwrites return address to point to a piece of code *not* supplied by the attacker
- For example, `system` call in libc:

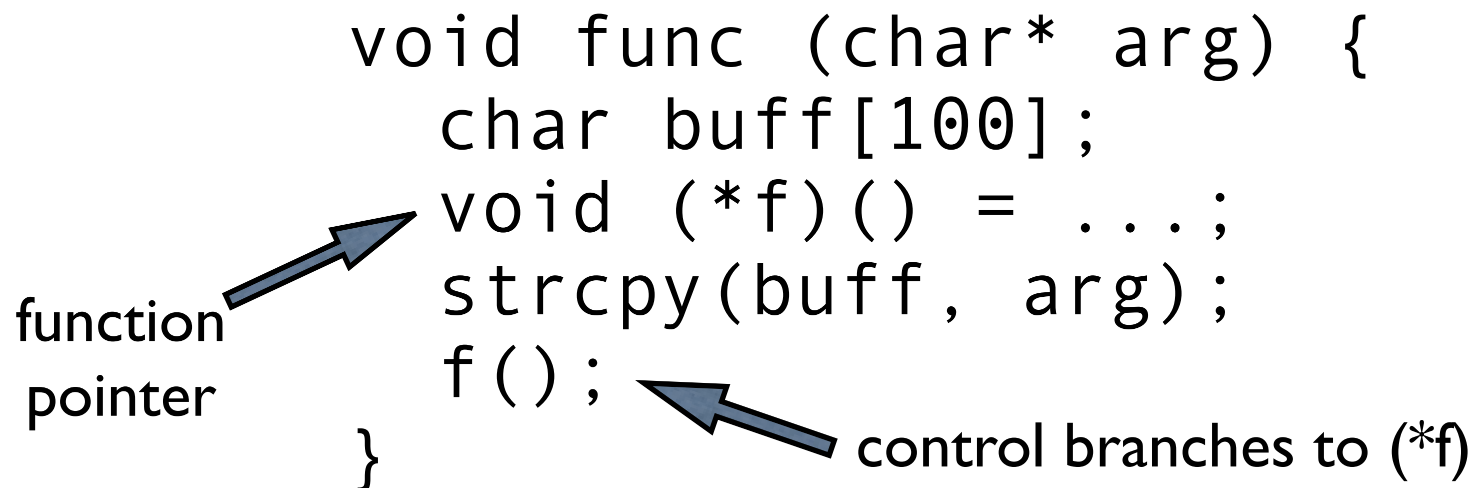
```
void system(char * arg){
  check_validity(arg);
  R = arg;
  execl(R, ...)
}
```

register

target for attacker

Pointer Subterfuge

- Attacker overwrites a pointer instead of the return address
- Example: overwriting a function pointer



Heap Smashing

- Exploits buffer overflows in heap rather than on stack
- Often combined with pointer subterfuge (eg, overwriting a function pointer that is not a local variable)
- Gaining in popularity

Preventing Buffer Overflows

Stackguard (Cowan et al.)

- Instruments code during compilation:
  1. Augments `call` instructions to write a ‘canary word’ next to return address, and push it onto a ‘canary stack’
  2. Augments `return` instructions to first check that canary word is intact

ProPolice (Etoh & Yoda)

- Extension to Stackguard's method: they place canary word between local char[]'s and other local variables
- This protects against pointer subterfuge on the stack

StackShield

- Similar to StackGuard, but saves a copy of return address to check against
- If real return address has been overwritten, can either terminate program or use copy and let program keep running

CRED: Bounds Checking for C (Ruwase & Lam)

- Does bounds checking for all string/char[] accesses
- Only tool to detect all attacks in a testbed that includes all previously mentioned attacks
- Adds 26%-130% overhead to the program

Baratloo et al.

- Two dynamically loaded libraries: Libsafe replaces unsafe library functions with safe versions, and Libverify does return address verification
- Works on executables
- Slowdown is < 15% for all tested programs

Baratloo et al.

- Weaknesses of Libverify:
  1. Only prevents attacks that overwrite the return address
  2. For technical reasons, has to copy entire function to heap on each call

References

- Aleph I. "Smashing the stack for fun and profit." http://www.phrack.org/phrack/49/P49-16
- Baratloo, Singh, and Tsai. "Transparent runtime defense against smash stacking attacks." http://www.usenix.org/publications/library/proceedings/usenix2000/general/full_papers/baratloo/baratloo.pdf
- Cowan et al. "StackGuard" http://www.cse.ogi.edu/DISC/projects/immunix/StackGuard/usenixsc98.ps.gz

References

- Etoh & Yoda. "Protecting from stack-smashing attacks." http://www.trl.ibm.com/projects/security/ssp/main.html
- Ruwase & Lam. "A practical dynamic buffer overflow detector." http://suif.stanford.edu/papers/tunji04.pdf
- Stackshield. http://www.angelfire.com/sk/stackshield