Developing Secure Things

Ways to not go as far wrong as you might…

Some Materials

OWASP

- https://www.owasp.org/index.php/Main_Page

SANS

- https://www.sans.org/security-resources/

Flawfinder and more

- https://www.dwheeler.com

Next hour

- Engineering approach
- Buffer overruns
- Defensive Programming
- Education

Security Engineering

- Networked applications need to be secure
  - not only security software needs to be secure
- Security is a dynamic property that changes with the environment
- Security cannot easily be added to an existing system
  - like safety, dependability, reliability, ...
  - not just triggered by faults, but by active opponents
- Security is a behavioral property of a complete system in a particular environment

Penetrate and Patch is Bad

- Most developers worry about security once their program is compromised - issue patch
- Problems with penetrate and patch:
  - Only known problems can be patched (the bad guy may never report the problem)
  - Patches often go unapplied
  - Patches are rushed out and may introduce new bugs
  - Patches only fix the symptom

Proactive Security Approach

- Security must be designed into the application from the beginning
- Five-step process:

1) Design software with security in mind
2) Analyze the system with respect to anticipated risks
3) Rank risks according to severity
4) Test for risks
5) Cycle a defect system through the design process

- Defects should be found and fixed before the software is released

Design for Security

- Design with the intended environment in mind
  - don’t rework centralized applications to be used on the Internet - too many assumptions may fail
- Define a threat model - explicitly state what security problems are addressed
- Document security decisions
  - don’t state that “the program encrypts necessary data”
  - state why encryption is used
  - state where encryption is used

Analyze the System

- Highly specialized task (special “tiger teams”)
- Never analyze your own code (external analysis)
  - biased view on code - likely to miss mistakes
  - use security conscious programmers (colleagues)
- Start with the written specification
  - identify risks

Rank Risks

- Consider environment and threat model
  - is this attack probable or stopped by firewall?
  - what are the consequences?
    - DoS is not serious for clients but fatal for web-servers
- Templates or standard lists of known risks are often useful to consider

Test for Risks

- Use the ranked list of risks to direct testing
  - create test cases to reveal problems or “interesting” behavior
  - inspect code to determine extent of problem
- Security testing includes abusing the program
  - don’t just use it as intended
  - feed it strange input (malformed data, long lines)
- Code coverage should be complete
  - “dead code” is a potential stable for a Trojan horse

Redesign if System Fails

- Examine sources if the system fails the tests
- Correct simple errors:
  - buffer overflows are simply solved (build prevention/detection into your development processes)
- Complex errors must result in a redesign
  - this will delay the release of the program, but it is necessary

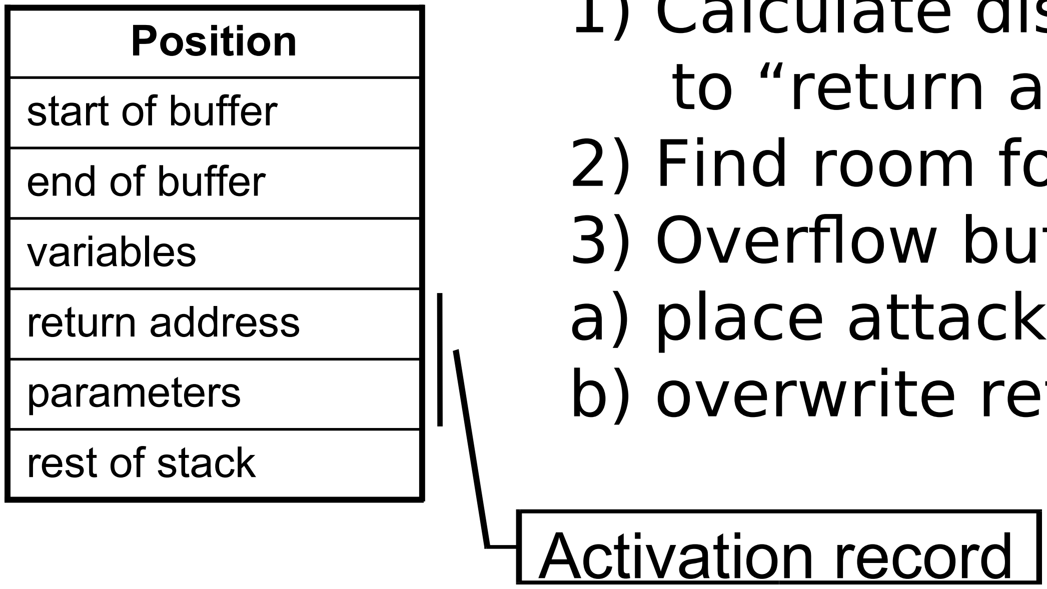
Buffer Overflows

- Very common vulnerability, more than 50% of incidents reported to CERT
- A parameter contains more data than an internal buffer can handle
- The buffer overflows and overwrites other variables allocated in nearby memory

This problem is solved in type-safe languages like Java

How do Buffer Overflows Work

Application memory



Position
start of buffer
end of buffer
variables
return address
parameters
rest of stack

1) Calculate distance from buffer to “return address”
2) Find room for attack code
3) Overflow buffer

a) place attack code on stack

b) overwrite return address

Principles of Robust Programming

- Code must handle bad input reasonably
- Controlled termination on internal errors
- 4 Principles of Robust Programming
  - Paranoia
  - Stupidity
  - Dangerous Implements
  - Can’t Happen

[Matt Bishop]

Paranoia

- Don’t trust anything you don’t generate
- Whenever someone calls your library, assume they will try to break it
- Always check return codes of function calls
- Assume you make mistakes, program defensively so they will be discovered quickly

Stupidity

- Assume the caller or user is an idiot, who cannot read the manual
- Write code that handles incorrect, bogus and malformed input
  - error messages must be self-explanatory
- If you detect problems, correct the error immediately or stop, to prevent error propagation

Dangerous Implements

- A dangerous implement is anything that your code assumes to remain fixed across function calls, e.g. file pointers in I/O calls
- Never give direct access to dangerous implements - use tokens instead of pointers
- Hiding data structures also makes your program more modular

Can’t Happen

- Impossible cases normally are not, just highly improbable
- Implement code that handles impossible cases
  - check impossible cases and print an error message if they occur
- “Robust Programming” is defensive
  - protect your program from users
  - protect your program from yourself

Beware of everything - even your own code!

Education

- We know we should include consideration of security at various stages
- Will only happen when relevant people have bought into that concept
- Who?
  - Management, Senior Developers/Designers, Customers
- Use a mixture of arguments:
  - Frightening, like-insurance, enabler, customer requirement

Modern Dev. Processes

- Agile processes tend to prioritise running code over design effort (no more waterfalls:-)
  - Good that there's less theoretical stuff, less good that there's less thought
- Move away from traditional Quality Assurance (QA) teams (test teams) towards DevOps
  - https://en.wikipedia.org/wiki/DevOps
    - It's wikipedia but good enough:-)
  - Yahoo killing QA teams => fewer errors!
    - https://spectrum.ieee.org/view-from-the-valley/computing/software/yahoos-engineers-move-to-coding-without-a-net
- What are the security consequences?
  - Less separation/isolation between developers and those with operational access (bad, private keys in repos)
  - More involvement of those with operations clue in development (good, real threats/mitigations more obvious)

Testing...

- Memory leaks are bad: valgrind is a fine tool
- Fuzzing is a fine way to break things to make them better
- Lesson: seek out the current good tools for your development environment and use those to test your code/systems

How much is enough?

- When is a heavyweight or lightweight process better?
- Say for s/w product development
  - Heavy: ITSEC/CC; Formal internal reviews; tiger-teams
  - Light: Internal reviews; occasional external consultants; learn-as-you-go
- What should *always* be done?