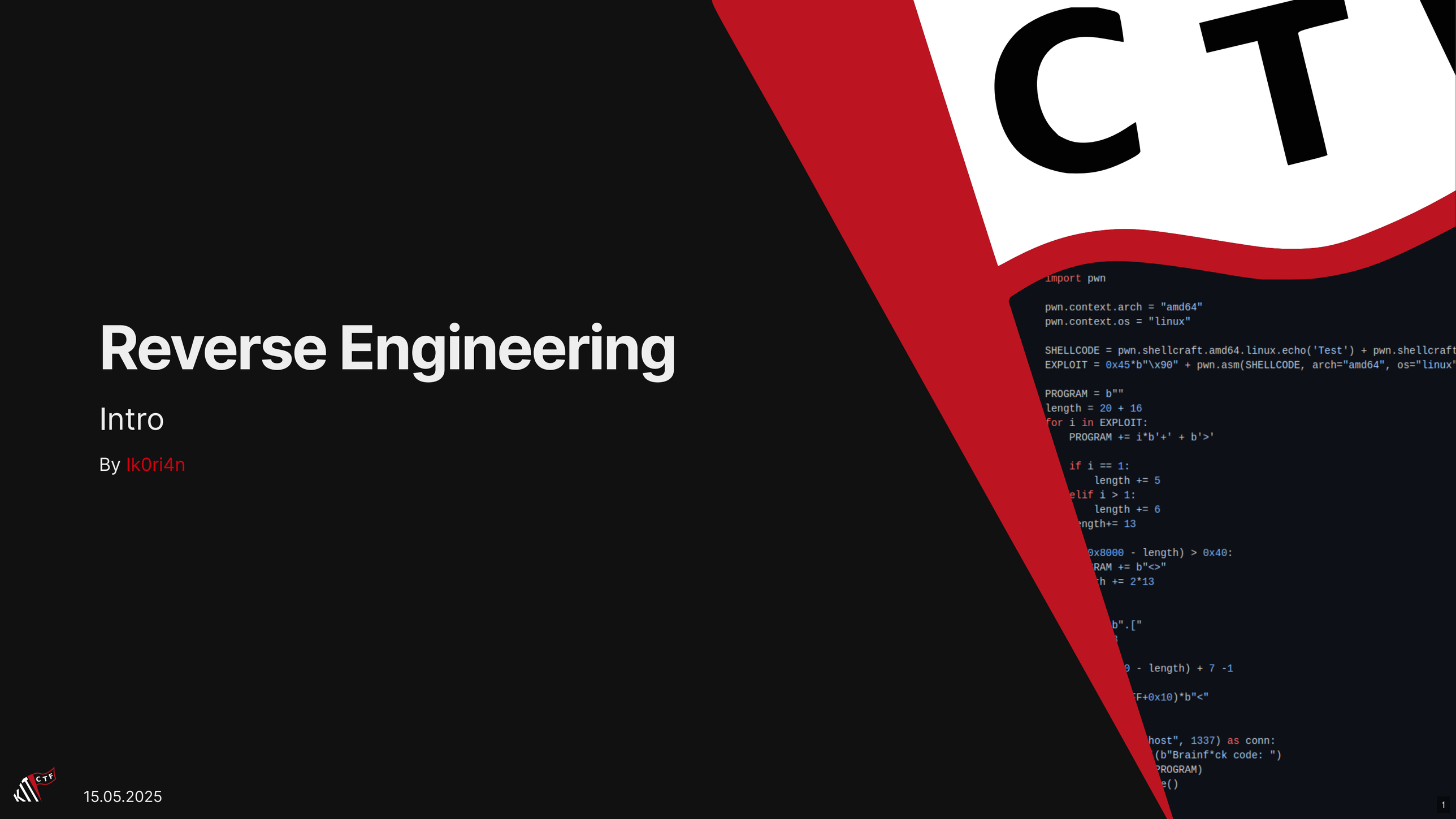
Reverse Engineering

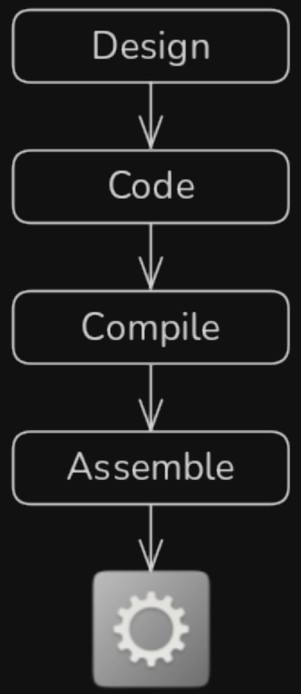
Intro

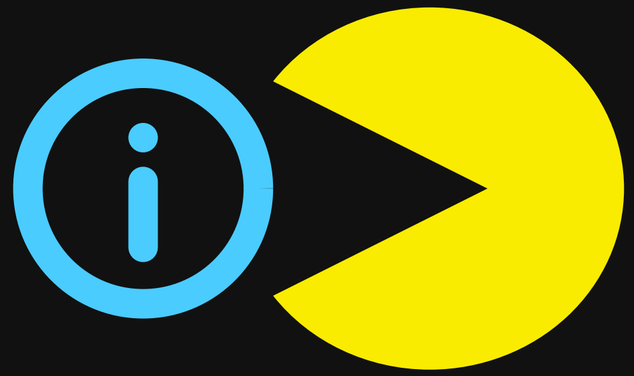
By Ik0ri4n



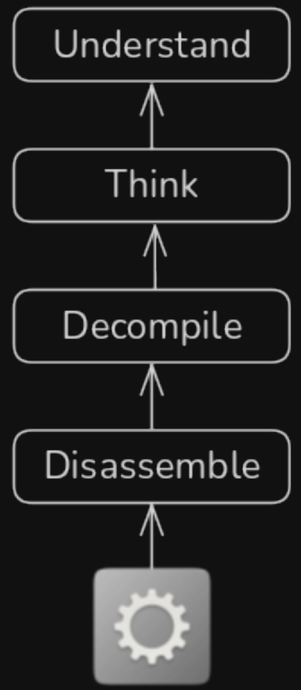
15.05.2025

Forward engineering process





Reverse engineering process



Why would I need that?

- CTF
- Vulnerability research
- Malware analysis
- No docs, source available
- Modding, Cracking

...plus it's fun!

What are we dealing with?

```
$ file chal
    chal: ELF 64-bit LSB pie executable,
    x86-64,
    version 1 (SYSV),
    dynamically linked,
    interpreter /lib64/ld-linux-x86-64.so.2,
    BuildID[sha1]=e7f3e971abeb24c4d7cc7747b3274f3058e749af,
    for GNU/Linux 3.2.0,
    stripped
```

- ELF Executable and Linkable Format
- Dynamic linker loads and links required shared libraries at run time ⇒ Symbols

Important ELF sections

- .text: executable code of the program
- .plt & .got: used to resolve and dispatch library calls
- .data: pre-initialized global writable data
- .rodata: pre-initialized global read-only data
- .bss: uninitialized global writable data

Useful tools

- readelf to parse the ELF header
- objdump to parse the ELF header and disassemble the source code
- nm to view your ELF's symbols
- patchelf to change some ELF properties
- objcopy to swap out ELF sections
- strip to remove otherwise-helpful information (such as symbols)

Static analysis tools

- file type infos based on magic bytes
- binwalk identify & opt. extract embedded files and data
- strings dumps strings found in file
- objdump simple disassembler
- checksec check security features

x86 Opcodes & Instructions:

- coder64 reference, raw byte format
- Felix Cloutier, web adaptation of intel manual
- OST 2 - Architecture 1001: x86-64 Assembly

Decompilers

Open source:

- Ghidra reverse engineering tool created by NSA
- angr management academic binary analysis framework
- cutter reverse engineering tool powered by Rizin

Commercial:

- Binary Ninja sleek, affordable IDA competitor (free and cloud version)
- IDA pro "gold standard" of disassemblers (expensive)

Demo time

Talk: Advanced Ghidra (useful extensions, tricks)

Rev player trust issues

Tool output is not always perfect!

- `file` checks *known* magic bytes (first match)
- Decompilers make (wrong) assumptions all the time!
- Tool output may differ (different strengths)

Know your tools!

Dynamic approach

Debugging with gdb

pwndbg: community-powered extension (lots of features)

Updates .gdbinit on installation

Overview

Function	Meaning
help	Print list of commands and specific help
pwndbg	Print list of pwndbg commands
run args	Run the program
starti args	Run the program and break on first instruction
break expr	Break at the given address or symbol
watch expr	Break when a value is written to the given address
rwatch expr	Break when a value is read from the given address
continue	Continue program execution
si and ni	Step into and step over

Examine Memory

```
x/<amount><format><size> <expr>
```

Parameter	Meaning
amount	Number of things to read
format	Output format, notably x, a, s for hex, addresses, and strings
size	Size of the data blocks, b, h, w, g for 1, 2, 4, 8 bytes respectively
expr	C-like expression describing data location

telescope [addr] [count] Recursively dereference pointers (e.g., stack overview)

Automated debugging

- gdb Command Files: run scripts with gdb commands
- pwntools: lots of functionality for scripting (see `pwnlib.gdb`)
- libdebug: simple API to debug programmatically

Dynamic analysis tools

- strace trace system calls
- ltrace trace library calls
- gdb GNU debugger
- Emulators

Further reading

Processor ISA Manuals

Gdb and Pwndbg documentation

Ghidra Book

ost2.fyi

Other helpful tools

- angr symbolic execution
- SMT solvers (e.g., z3)
- SageMath (ask our crypto players 😉)

Lots plugins and tools for specific use cases

And... Action!

Start playing at intro.kitctf.de

Demo alternative

YouTube @stacksmashing

Good quickstart guide & reversing series!