Public Preview Version

# Reversing Disassembly Reconstruction

## Accelerated

**Revised Version**

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# Prerequisites

- Working C or classic C++ knowledge
- Basic assembly language knowledge

# Audience

- Novices

Learn x64 assembly language

- Experts

Learn the new pattern approach

# Pattern-Oriented RDR

- Complex crashes and hangs (victimware analysis)
- Malware analysis
- Studying new products

# Training Goals

- Review fundamentals
- Learn patterns and techniques

# Training Principles

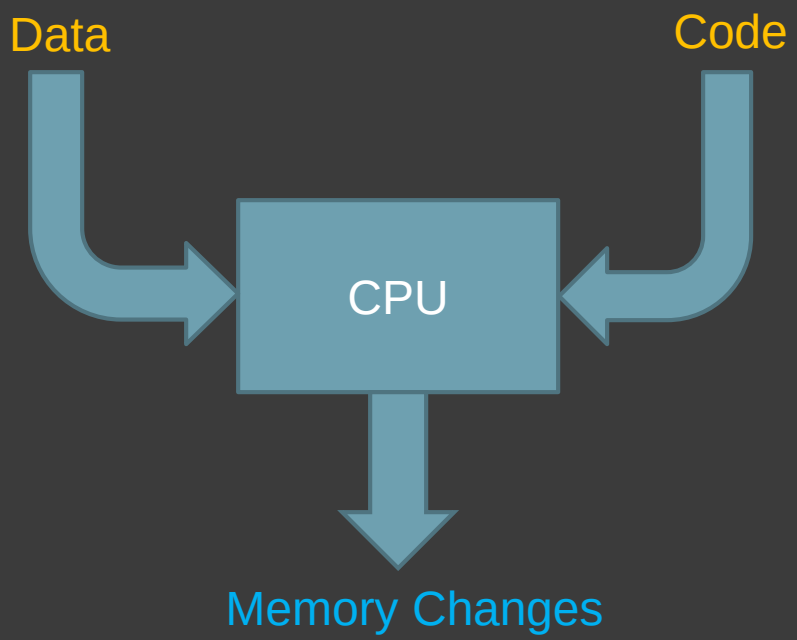
- Talk only about what I can show
- Lots of pictures
- Lots of examples
- Original content and examples

# Course Idea

- Implicit memory leak resulted from wrong API call parameter
- Debugging.TV episode 0x31

# Part 1: Theory

# Computation



# Disassembly

Data/Code numbers

Data/Code symbolic

```
488d0d2cce0000  lea rcx,[CPUx64+0xe2f8 (00000001`3f85e2f8)]  ; "Hello World!"
```

**Annotated Disassembly** memory analysis pattern

# The Problem of Reversing

- Compilation to **M**achine Language$_M$

Language$_1$  Language$_M$  Language$_2$

- Decompilation

Language$_M$  ?

# The Solution to Reversing

- **M**emory Language$_M$ Semantics

Language$_1$  Language$_M$  Language$_2$

- Decompilation

Understanding of Language$_M$

# The Reversing Tool

| RSP | | | | |
|---|---|---|---|---|
| 8 | | | | |
| 10 | | | | |
| 18 | | | | |
| 20 | | | | |
| 28 | | | | |
| 30 | | | | |
| 38 | | | | |
| 40 | | | | |
| 48 | | | | |
| 50 | | | | |

Memory Cell Diagrams

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| RAX | | | | | | | |
| | | | | | | | |
| | | | | | | | |
| | | | | | | | |
| | | | | | | | |

# Re(De)construction

- Time dimension: sequence diagrams
- Space dimension: component diagrams

How does it work temporally and structurally?

# ADDR Patterns

- Accelerated
- Disassembly patterns
- De(Re)construction patterns
- Reversing patterns

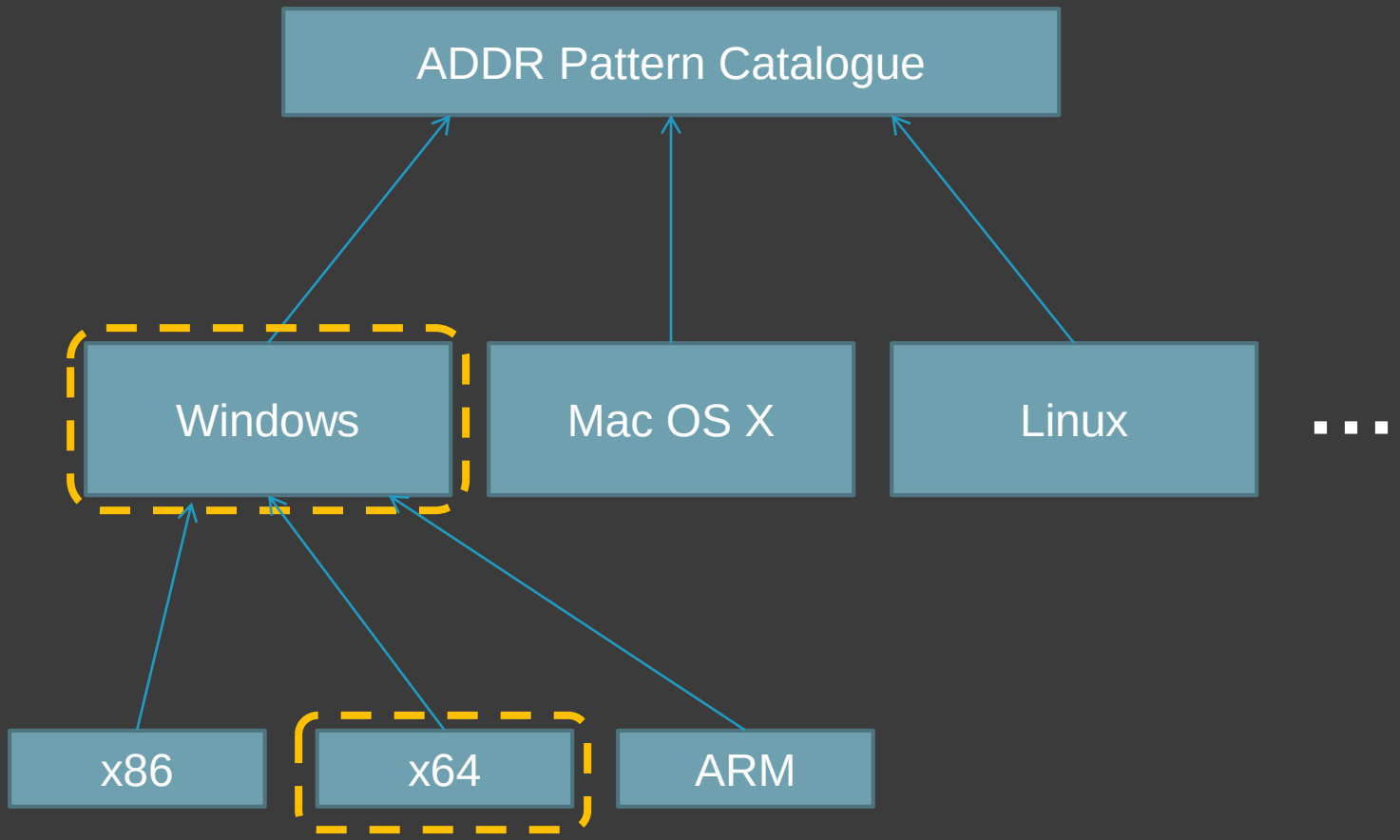
# ADDR Patterns (II)

- Accelerated
- Disassembly patterns
- Decompilation patterns
- Reconstruction patterns

# ADDR Schemas

- Function Prologue -> Function Epilogue
- Call Prologue -> Function Call -> Call Epilogue
- Potential Functionality -> Call Skeleton -> Call Path
- Call Parameter -> Function Parameter -> Local Variable

# ADDR Implementations



# Pattern Catalogues

- Elementary Software Diagnostics Patterns
- Memory Analysis Patterns
- Trace and Log Analysis Patterns
- Unified Debugging Patterns
- ADDR Patterns

# Pattern Orientation

- Pattern-Driven ADDR

- Pattern-Based ADDR

# Part 2: Practice Exercises

# Links

- Memory dumps:

NOT IN THE PUBLIC PREVIEW VERSION

- Exercise Transcripts:

NOT IN THE PUBLIC PREVIEW VERSION

# Exercise 0

- **Goal:** Install Debugging Tools for Windows and WinDbg Preview and check that symbols are setup correctly

- \ADDR\Exercise-0-Download-Setup-WinDbg.pdf

# Main CPU Registers

Illustrated on memory cell diagrams in \ADDR\MCD-R1.xlsx

- RAX ⊃ EAX ⊃ AX ⊇ {AH, AL}
- ALU: RAX, RDX
- Counter: RCX
- Memory copy: RSI (src), RDI (dst)
- Stack: RSP
- Next instruction: RIP
- New: R8 – R15, Rx(D|W|B)

# Exercise R1

- **Goal:** Review x64 assembly fundamentals; learn how to reconstruct stack trace manually
- **ADDR Patterns:** Universal Pointer, Symbolic Pointer $S^2$, Interpreted Pointer $S^3$, Context Pyramid
- **Memory Cell Diagrams:** Register, Pointer, Stack Frame
- \ADDR\Exercise-R1.pdf
- \ADDR\MCD-R1.xlsx

# Stack Reconstruction

1. Top frame from the current $RIP_1$, $RSP_1$ (**r**)
2. Disassemble around the current $RIP_n$ (**u**[**f**] $RIP_n$)
3. Find out the beginning of the function prologue
4. Check $RSP_n$ usage (**sub**, **push**) and count offsets
5. Get $RIP_{n+1}$ for the next frame (**dps** @$rsp_n$ + offset
6. Get $RSP_{n+1}$ for the next frame ($RSP_n$+8)
7. ++n
8. goto #2

# Exercise R2

- **Goal:** Learn how to map source code to disassembly
- **ADDR Patterns:** Potential Functionality, Function Skeleton, Function Call, Call Path, Local Variable, Static Variable, Pointer Dereference
- **Memory Cell Diagrams:** Pointer Dereference
- \ADDR\Exercise-R2.pdf
- \ADDR\MCD-R2.xlsx

# Exercise R3

- **Goal:** Learn a function structure and associated memory operations
- **ADDR Patterns:** Function Prologue, Function Epilogue, Variable Initialization, Memory Copy
- **Memory Cell Diagrams:** Function Prologue, Function Epilogue
- \ADDR\Exercise-R3.pdf
- \ADDR\MCD-R3.xlsx

# Exercise R4

- **Goal:** Learn how to recognize call and function parameters and track their data flow
- **ADDR Patterns:** Call Prologue, Call Parameter, Call Epilogue, Call Result, Control Path, Function Parameter, Structure Field
- \ADDR\Exercise-R4.pdf

# Exercise R5

- **Goal:** Master memory cell diagrams as an aid to understanding complex disassembly logic
- **ADDR Patterns:** Last Call, Loop, Memory Copy
- **Memory Cell Diagrams:** Memory Copy
- \ADDR\Exercise-R5.pdf
- \ADDR\MCD-R5.xlsx

# Exercise R6

- **Goal:** Learn how to map code to execution residue and reconstruct past behaviour; recognise previously introduced ADDR patterns in the context of compiled classic C++ code
- **ADDR Patterns:** Separator Frames, Virtual Call
- **Memory Cell Diagrams:** Virtual Call
- \ADDR\Exercise-R6.pdf
- \ADDR\MCD-R6.xlsx

# Live Debugging Techniques

- **ADDR Patterns:** Component Dependencies, API Trace, Fibre Bundle (trace analysis pattern)
- Some dependencies can be learnt from crash dump stack traces
- Debugging.TV / YouTube
- Live debugging training: Accelerated Windows Debugging[3]

# Resources

- WinDbg Help / WinDbg.org (quick links)
- DumpAnalysis.org / SoftwareDiagnostics.Institute
- PatternDiagnostics.com
- Debugging.TV / YouTube.com/DebuggingTV / YouTube.com/PatternDiagnostics
- Practical Foundations of Windows Debugging, Disassembling, Reversing
- Memory Dump Analysis Anthology

# Q&A

Please send your feedback using the contact form on PatternDiagnostics.com

Thank you for attendance!