Linux Debugging^4

Accelerated

Dmitry Vostokov
Software Diagnostics Services

Prerequisites

GDB Commands

We use these boxes to introduce GDB commands used in practice exercises

WinDbg Commands

We use these boxes to introduce WinDbg commands used in practice exercises

LLDB Commands

We use these boxes to introduce LLDB commands used in practice exercises

- Debugging at source code level

or

- Basic crash dump analysis

GDB & LLDB, but Why WinDbg?

- The latest choice of a live debugger for Linux
- Second pair of eyes
- Debugging cross platform code
- WSL

Training Goals

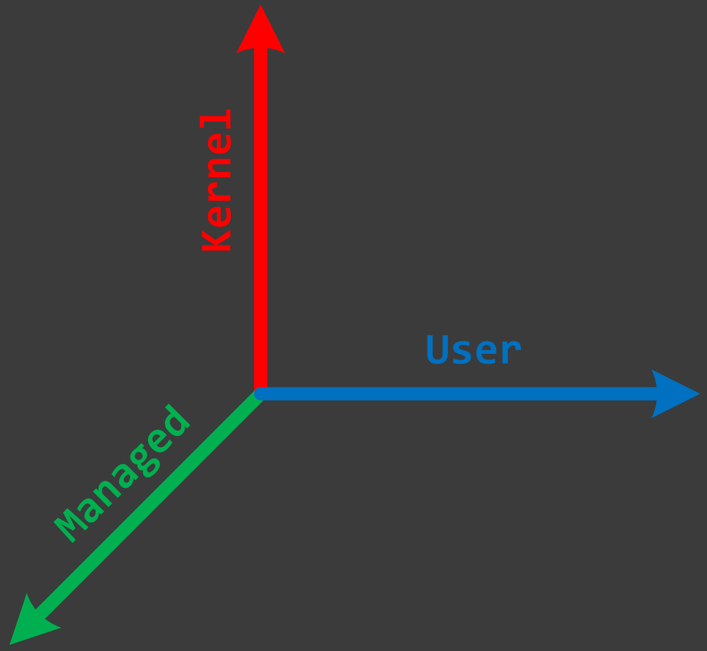
- Review fundamentals
- Learn live debugging techniques
- See how software diagnostics is used during debugging

Training Principles

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

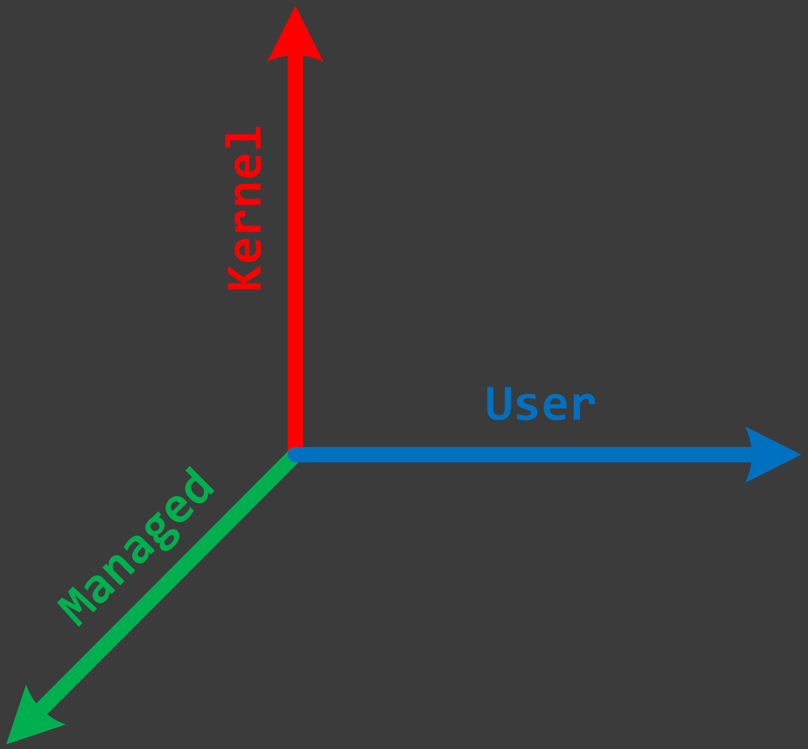
Course Idea

1. Chemistry^3: Introducing Inorganic, Organic, and Physical Chemistry book
2. Accelerated Windows Debugging^3 and Accelerated Windows Debugging^4

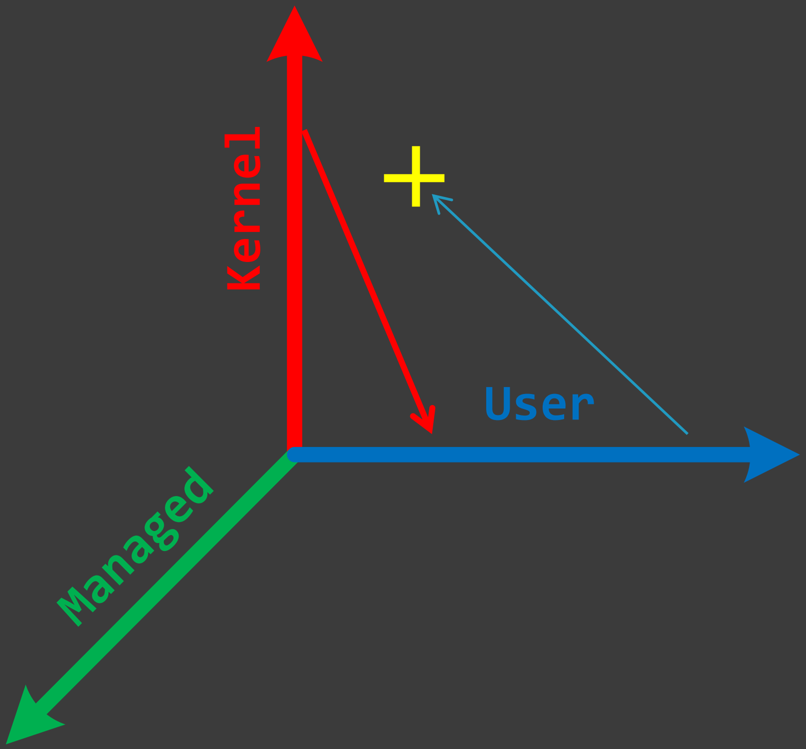


Part 1: Fundamentals

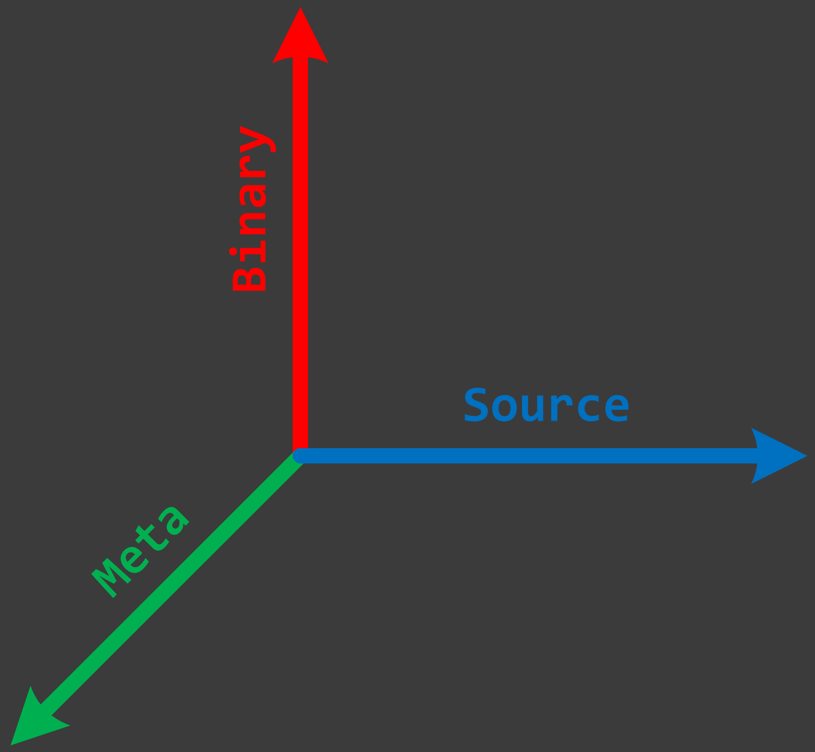
Memory Space^3



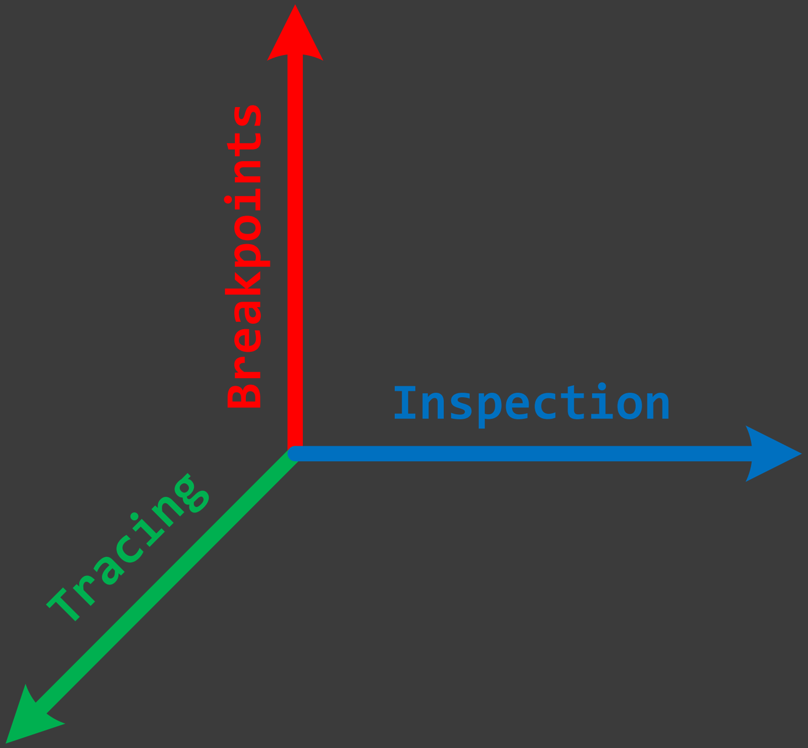
Execution Mode^3



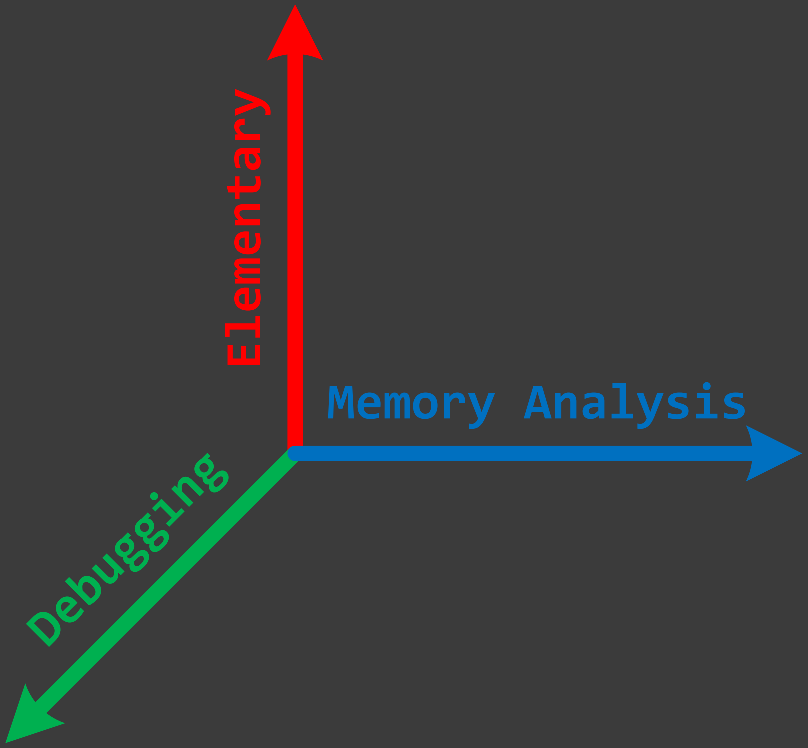
Code^3



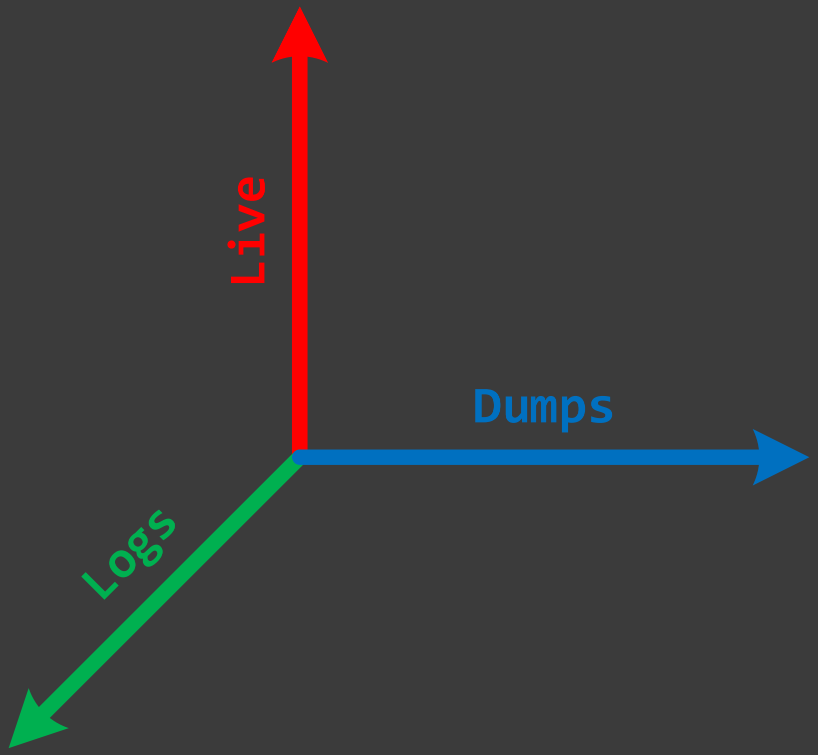
Live Debugging Technique^3



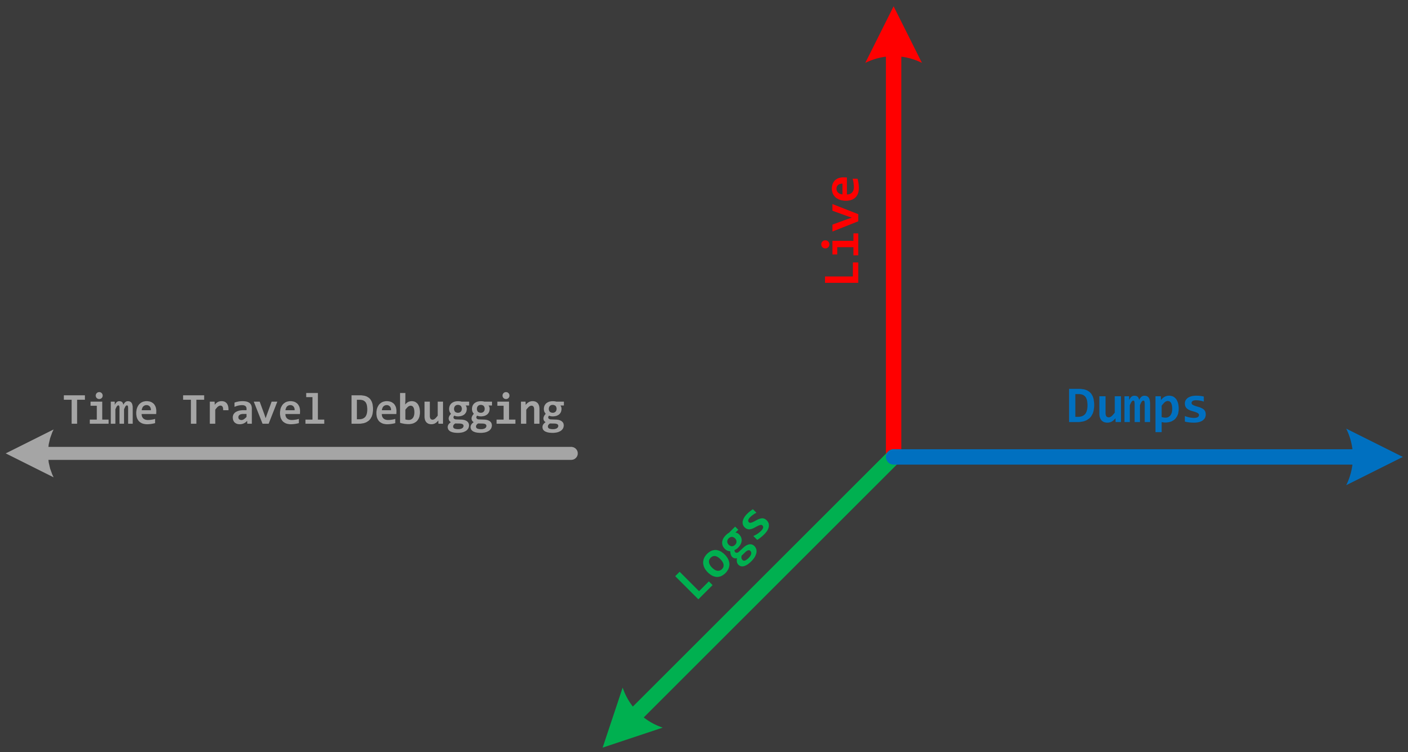
Pattern^3



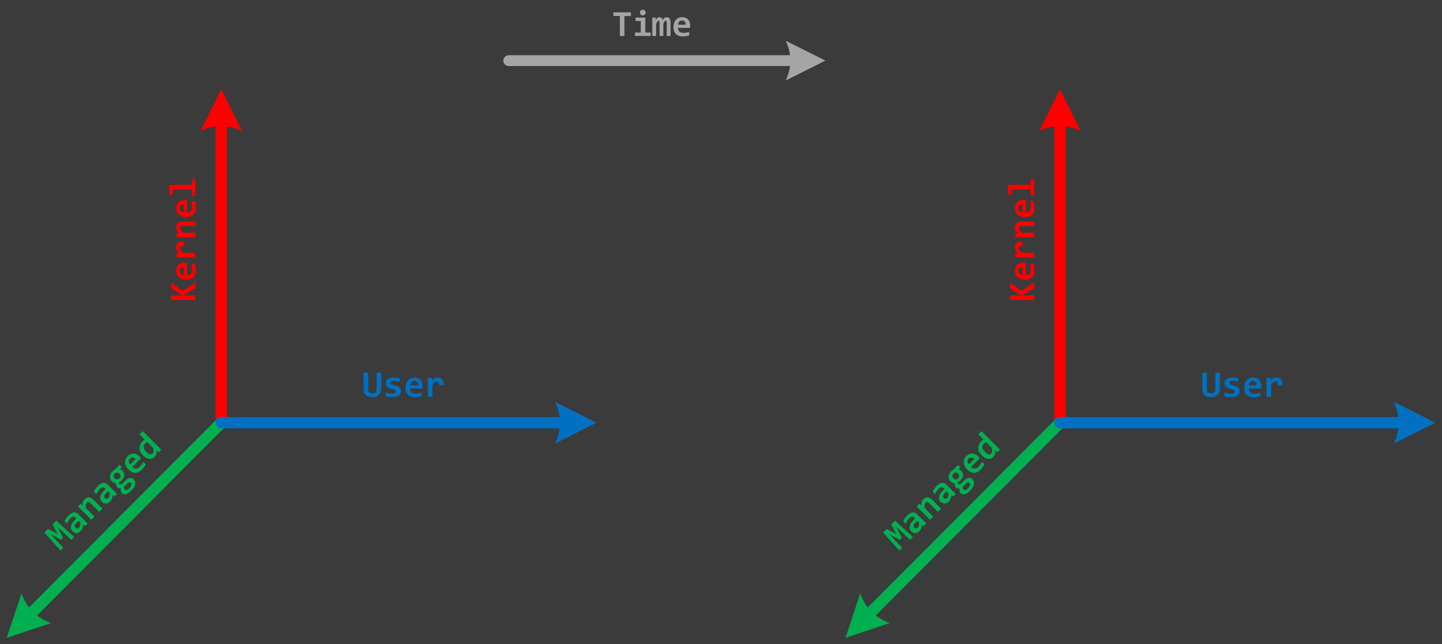
Debugging Paradigm^3



Debugging Paradigm^4

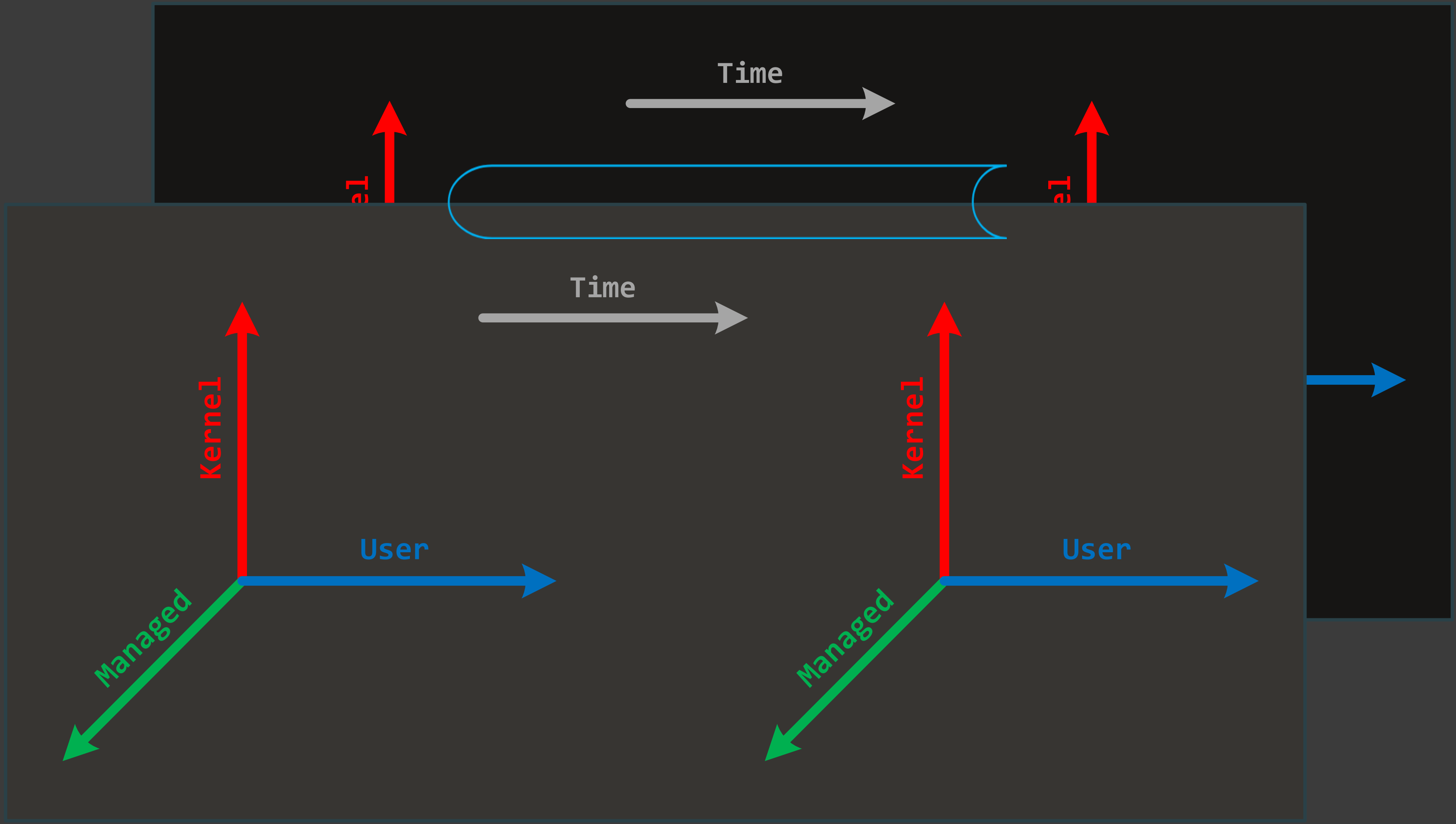


Memory Spacetime

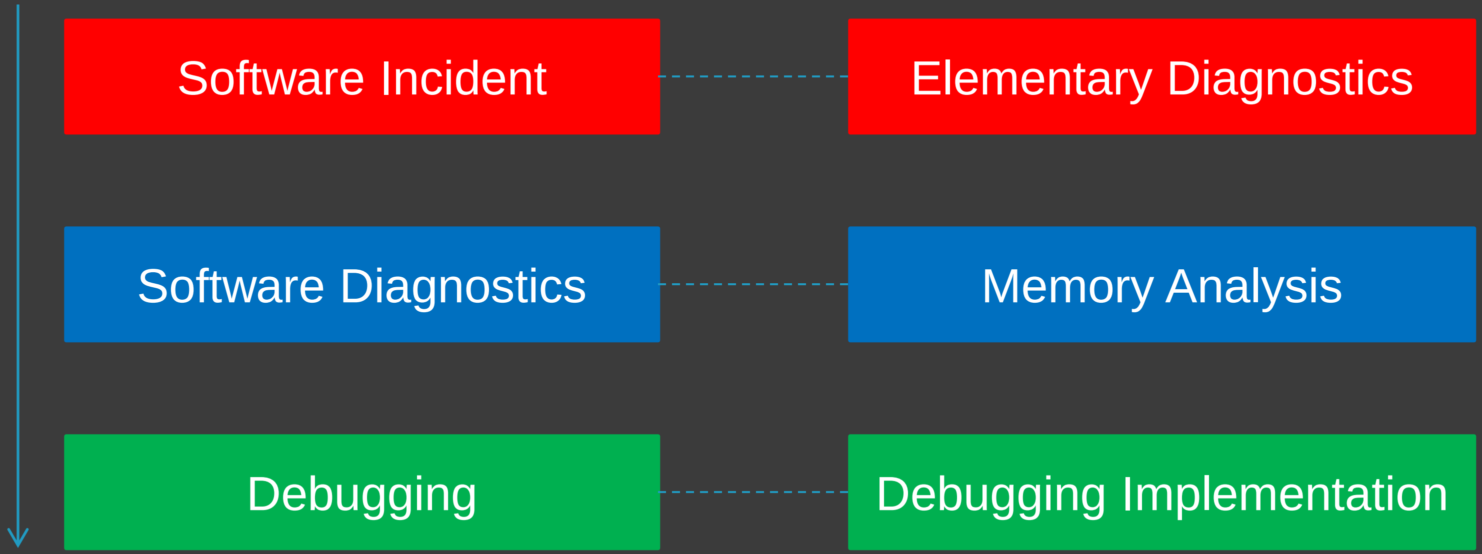


Debugging Paradigm^5

Idea: Kaluza-Klein Theory of a microscopic 5th dimension



Pattern Mapping



Software Incident

Elementary Diagnostics

Software Diagnostics

Memory Analysis

Debugging

Debugging Implementation

Elementary Diagnostics

- Functional
  - Use-case Deviation

- Non-functional
  - Crash
  - Hang (includes delays)
  - Counter Value (includes resource leaks, CPU spikes)
  - Error Message

Analysis Patterns

- Memory Analysis catalog
- Software Trace and Log Analysis catalog

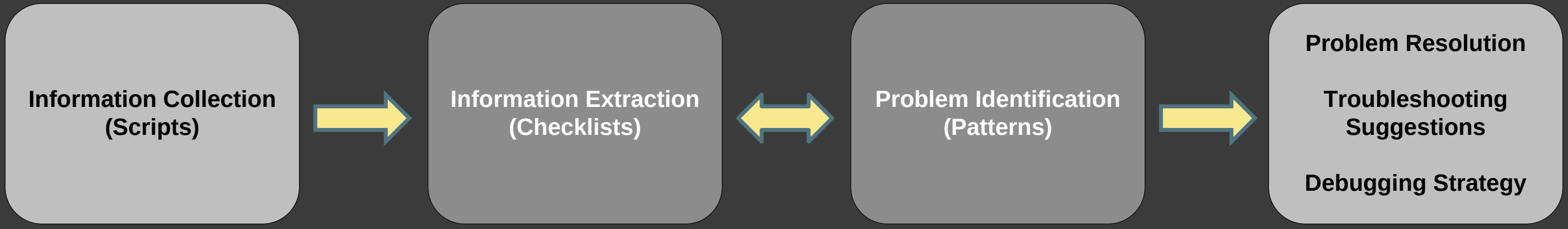
Pattern-Oriented Diagnostic Analysis

Diagnostic Pattern: a common recurrent identifiable problem together with a set of recommendations and possible solutions to apply in a specific context.

Diagnostic Problem: a set of indicators (symptoms, signs) describing a problem.

Diagnostic Analysis Pattern: a common recurrent analysis technique and method of diagnostic pattern identification in a specific context.

Diagnostics Pattern Language: common names of diagnostic and diagnostic analysis patterns. The same language for any operating system: Windows, Mac OS X, Linux, ...



Information Collection (Scripts)

Information Extraction (Checklists)

Problem Identification (Patterns)

Problem Resolution

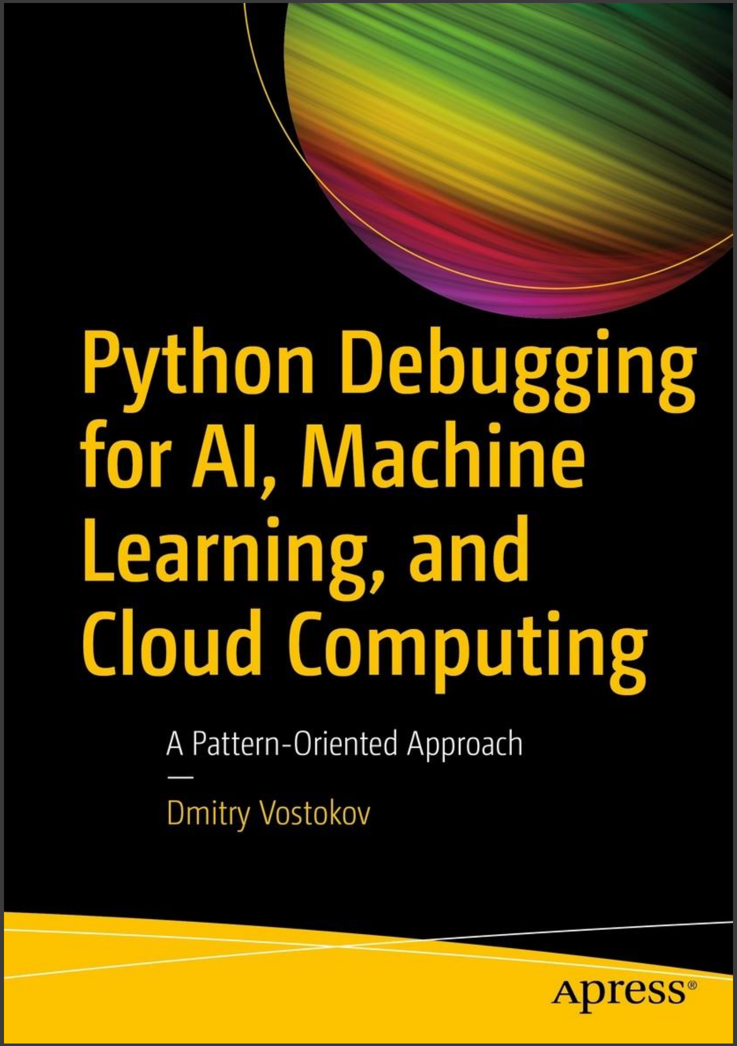
Troubleshooting Suggestions

Debugging Strategy

Unified Debugging Patterns

- Analysis (software diagnostics)
- Architecture/Design of debugging
- Implementation of debugging
- Usage/presentation of debugging (for example, Watch dialog)

Full Debugging Patterns Catalog

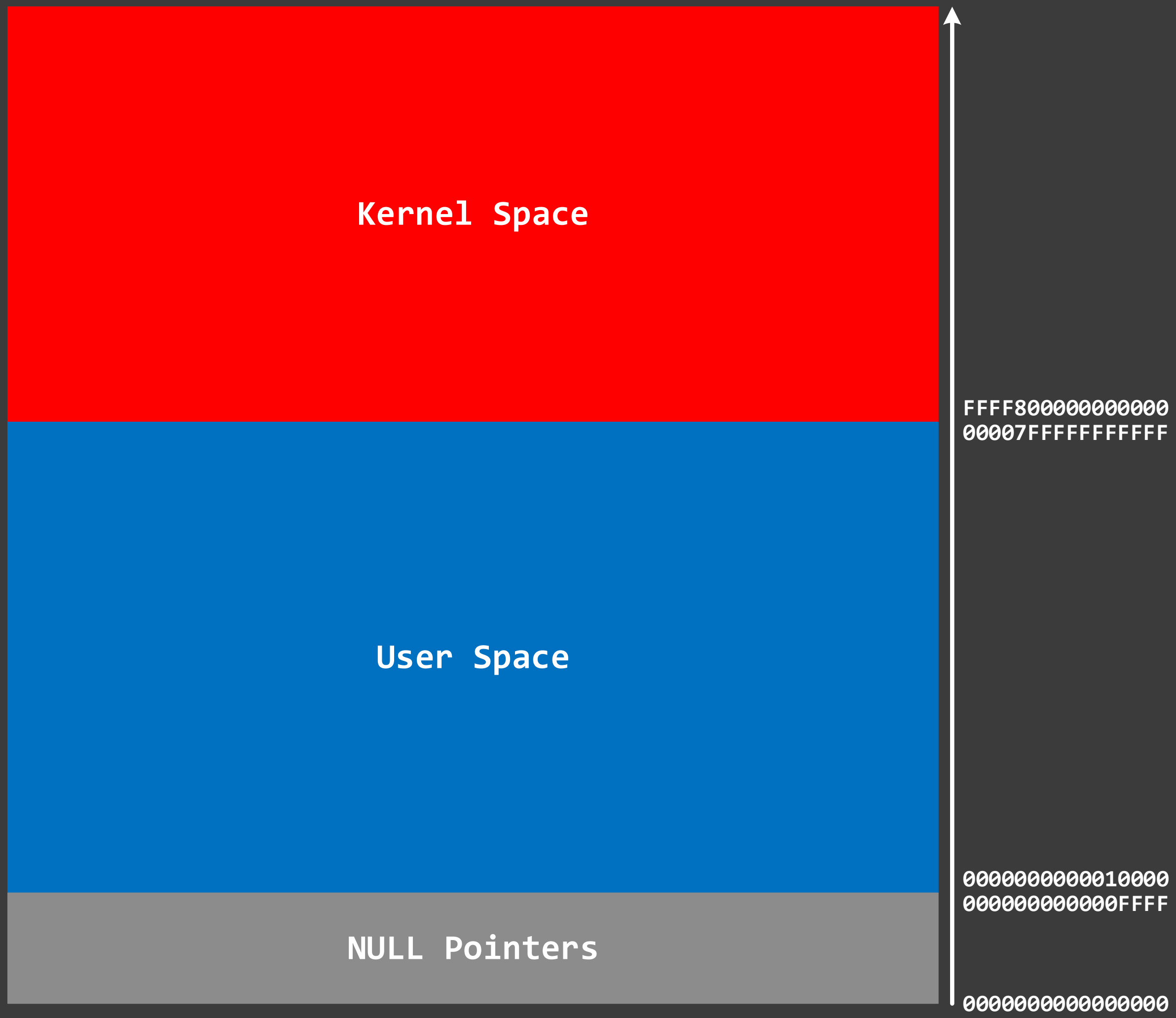


Python Debugging for AI, Machine Learning, and Cloud Computing

A Pattern-Oriented Approach

Dmitry Vostokov

Space Review (x64)



Kernel Space

User Space

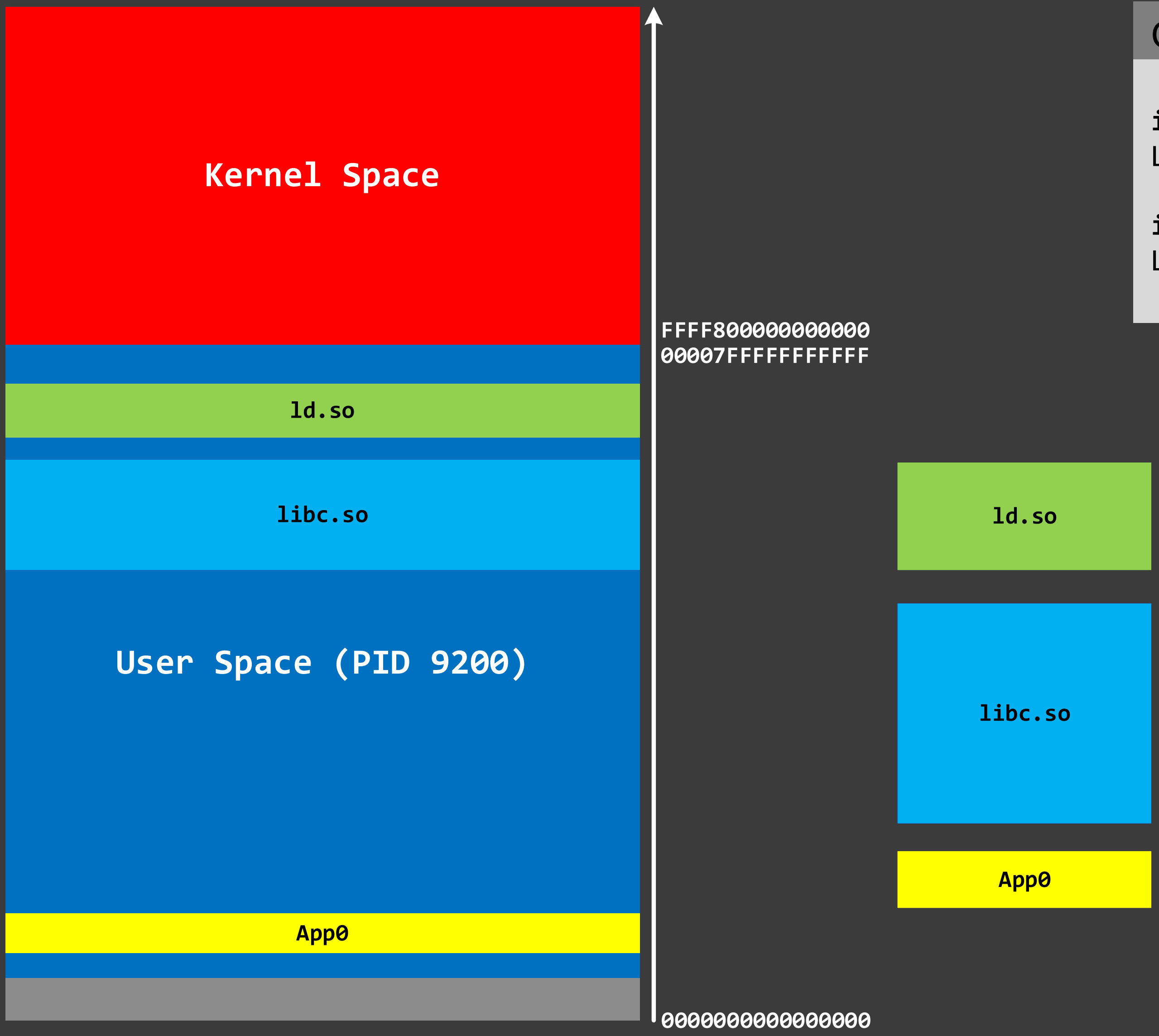
NULL Pointers

FFFF800000000000
00007FFFFFFFFFFF

0000000000010000
000000000000FFFF

0000000000000000

App/Process/Library



GDB Commands

`info sharedlibrary`
Lists dynamic libraries

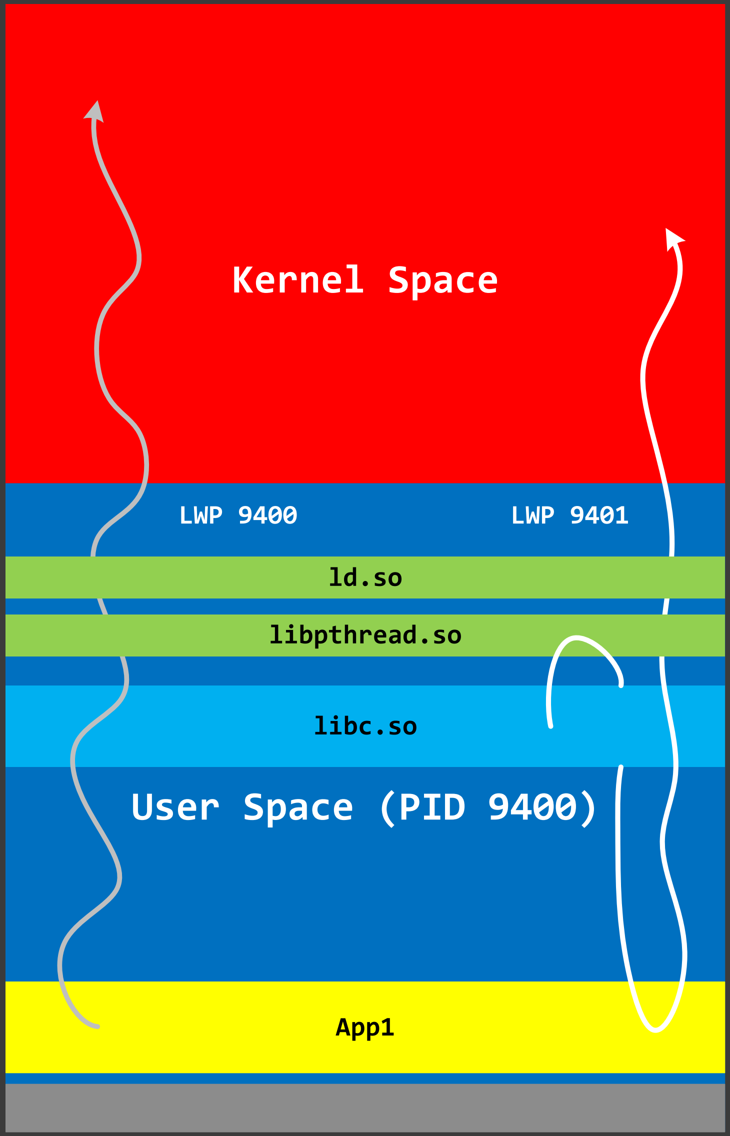
`info proc mappings`
Lists memory regions

WinDbg Commands

`lm`
Lists dynamic libraries

`!address`
Lists memory regions

Lightweight Processes (Threads)



GDB Commands

`info threads`
Lists threads

`thread <n>`
Switches between threads

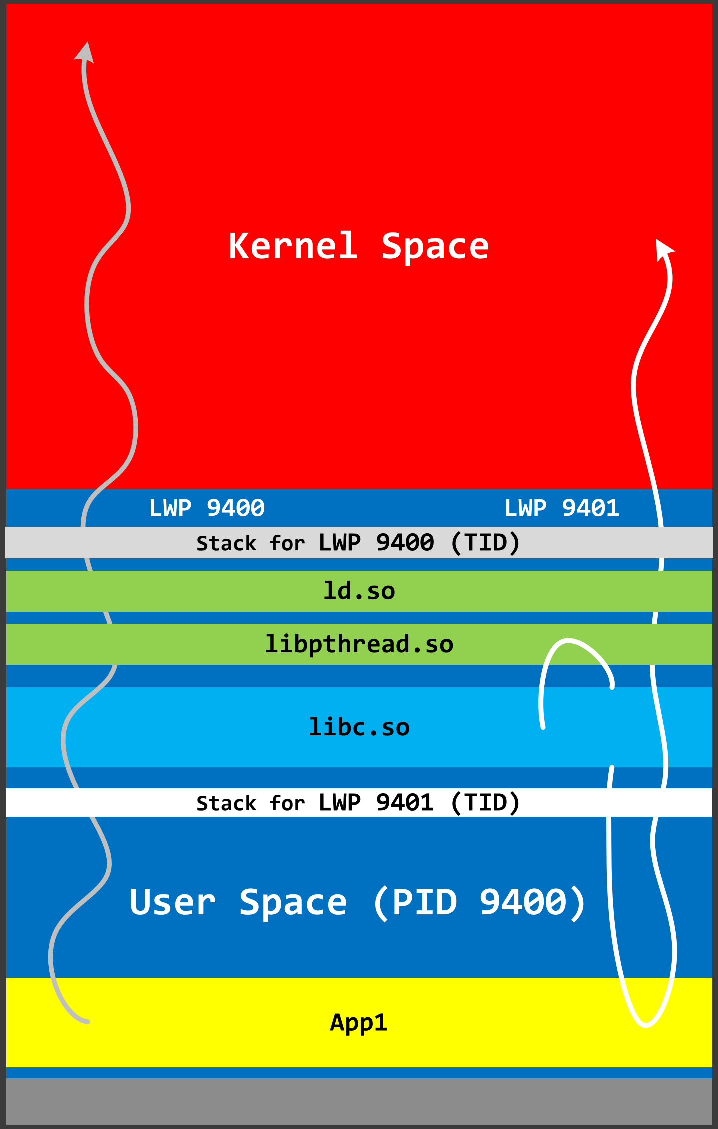
`thread apply all bt`
Lists stack traces from all threads

WinDbg Commands

`~*k`
Lists stack traces from all threads

`~<n>s`
Switches between threads

Thread Stack Raw Data



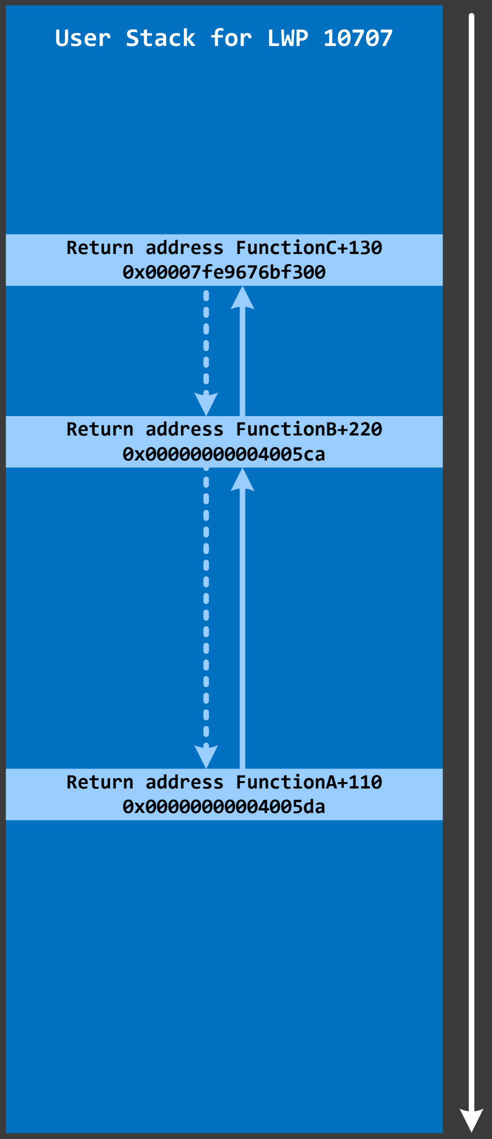
GDB Commands

`x/<n>a <address>`
Prints n addresses with corresponding symbol mappings if any

WinDbg Commands

`dps <address> L<n>`
Prints n addresses with corresponding symbol mappings if any

Thread Stack Trace



User Stack for LWP 10707

Return address FunctionC+130
0x00007fe9676bf300

Return address FunctionB+220
0x00000000004005ca

Return address FunctionA+110
0x00000000004005da

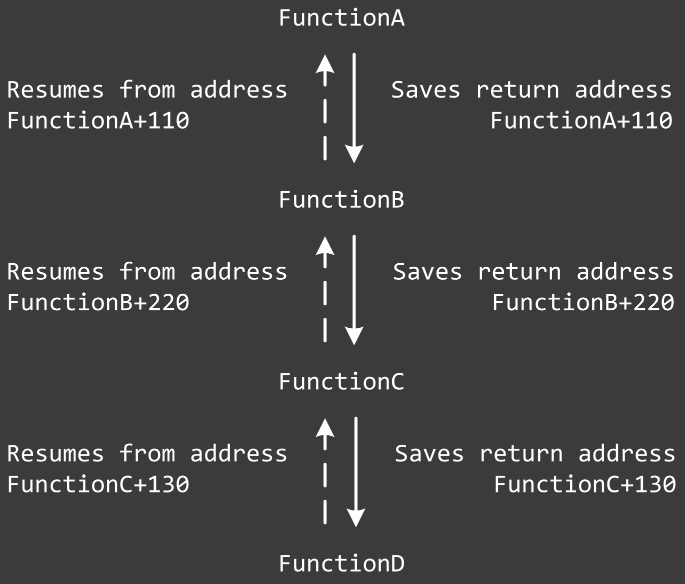
```
FunctionA()
{
  ...
  FunctionB();
  ...
}

FunctionB()
{
  ...
  FunctionC();
  ...
}

FunctionC()
{
  ...
  FunctionD();
  ...
}
```

GDB Commands

```
(gdb) bt
#0 0x00007fe9676bf48d in FunctionD ()
#1 0x00007fe9676bf300 in FunctionC ()
#2 0x00000000004005ca in FunctionB ()
#3 0x00000000004005da in FunctionA ()
```



FunctionA

Resumes from address
FunctionA+110

Saves return address
FunctionA+110

FunctionB

Resumes from address
FunctionB+220

Saves return address
FunctionB+220

FunctionC

Resumes from address
FunctionC+130

Saves return address
FunctionC+130

FunctionD

GDB vs. WinDbg vs. LLDB

GDB Commands

```
(gdb) bt
#0 0x00007fe9676bf48d in FunctionD ()
#1 0x00007fe9676bf300 in FunctionC ()
#2 0x00000000004005ca in FunctionB ()
#3 0x00000000004005da in FunctionA ()
```

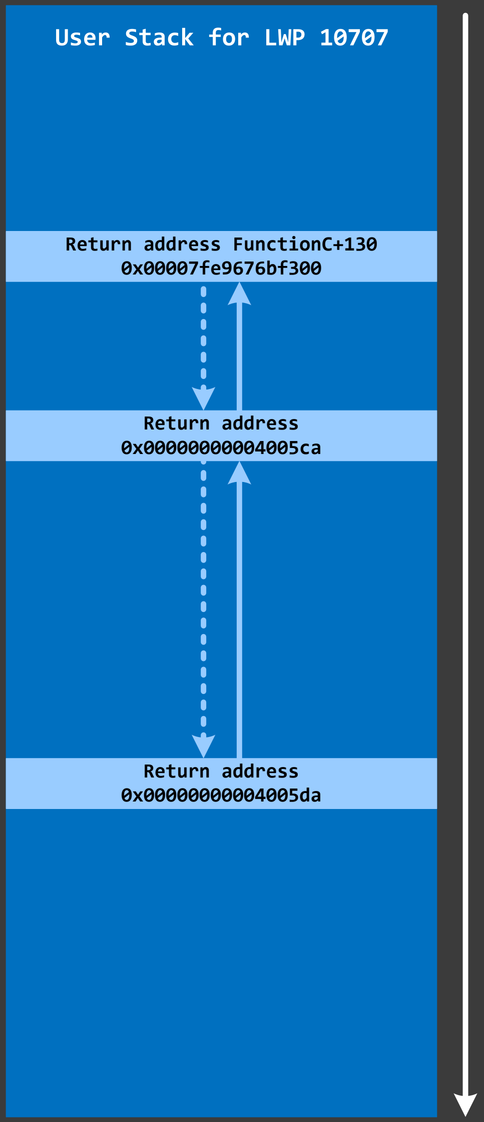
WinDbg Commands

```
0:000> k
00 00007fe9676bf300 Module!FunctionD+offset
01 00000000004005ca Module!FunctionC+130
02 00000000004005da AppA!FunctionB+220
03 0000000000000000 AppA!FunctionA+110
```

LLDB Commands

```
(lldb) bt
frame #0: 0x000000020328982a Module`FunctionD + offset
frame #1: 0x0000000203288a9c Module`FunctionC + 130
frame #2: 0x0000000104da3ea9 AppA`FunctionB + 220
frame #3: 0x0000000104da3edb AppA`FunctionA + 110
```

Thread Stack Trace (no symbols)



User Stack for LWP 10707

Return address FunctionC+130
0x00007fe9676bf300

Return address
0x00000000004005ca

Return address
0x00000000004005da

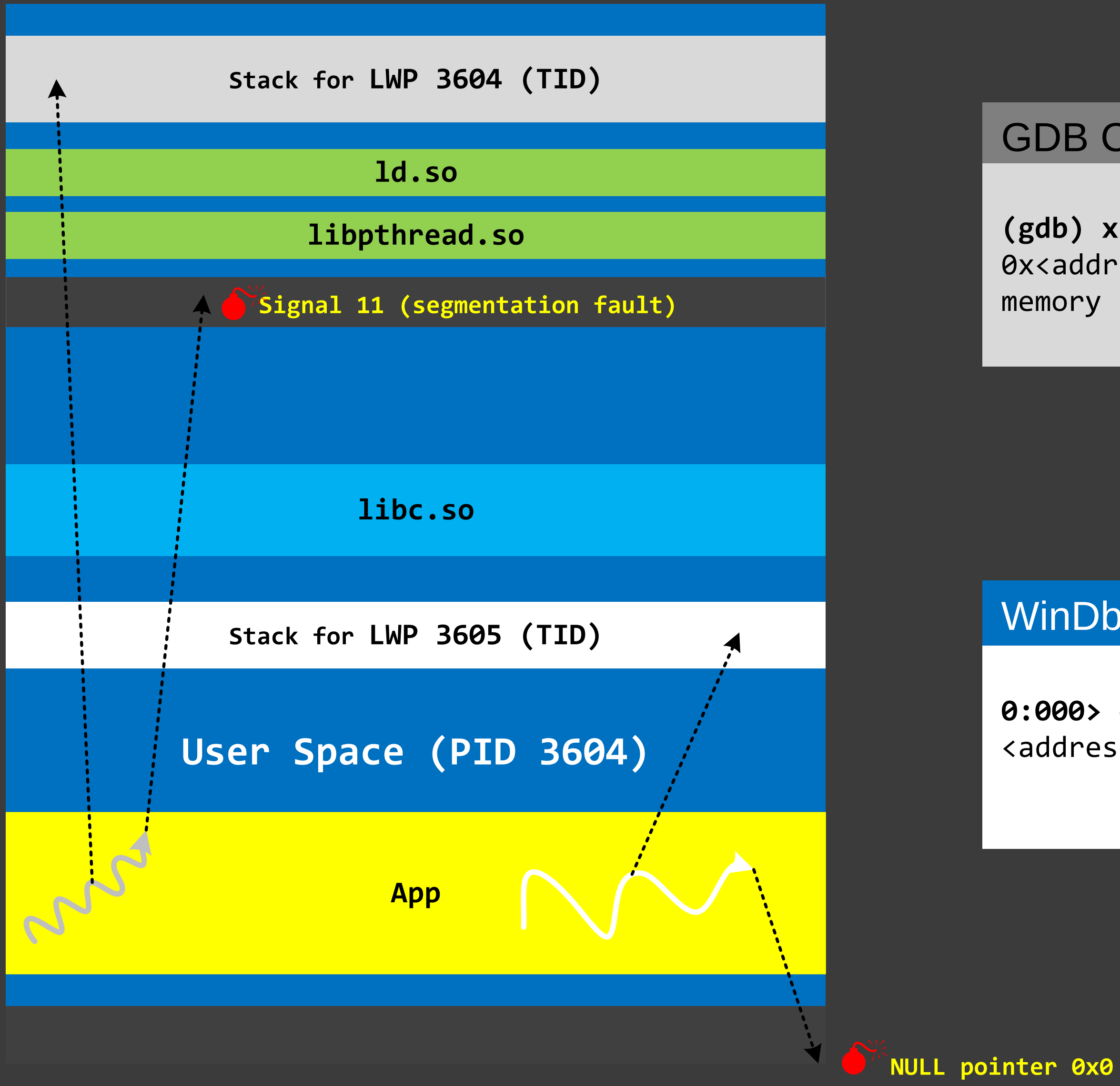
```
Symbol file App.sym

FunctionA 22000 - 23000
FunctionB 32000 - 33000
```

GDB Commands

```
(gdb) bt
#0 0x00007fe9676bf48d in FunctionD ()
#1 0x00007fe9676bf300 in FunctionC ()
#2 0x00000000004005ca in ?? ()
#3 0x00000000004005da in ?? ()
```

Exceptions (Seg Fault)



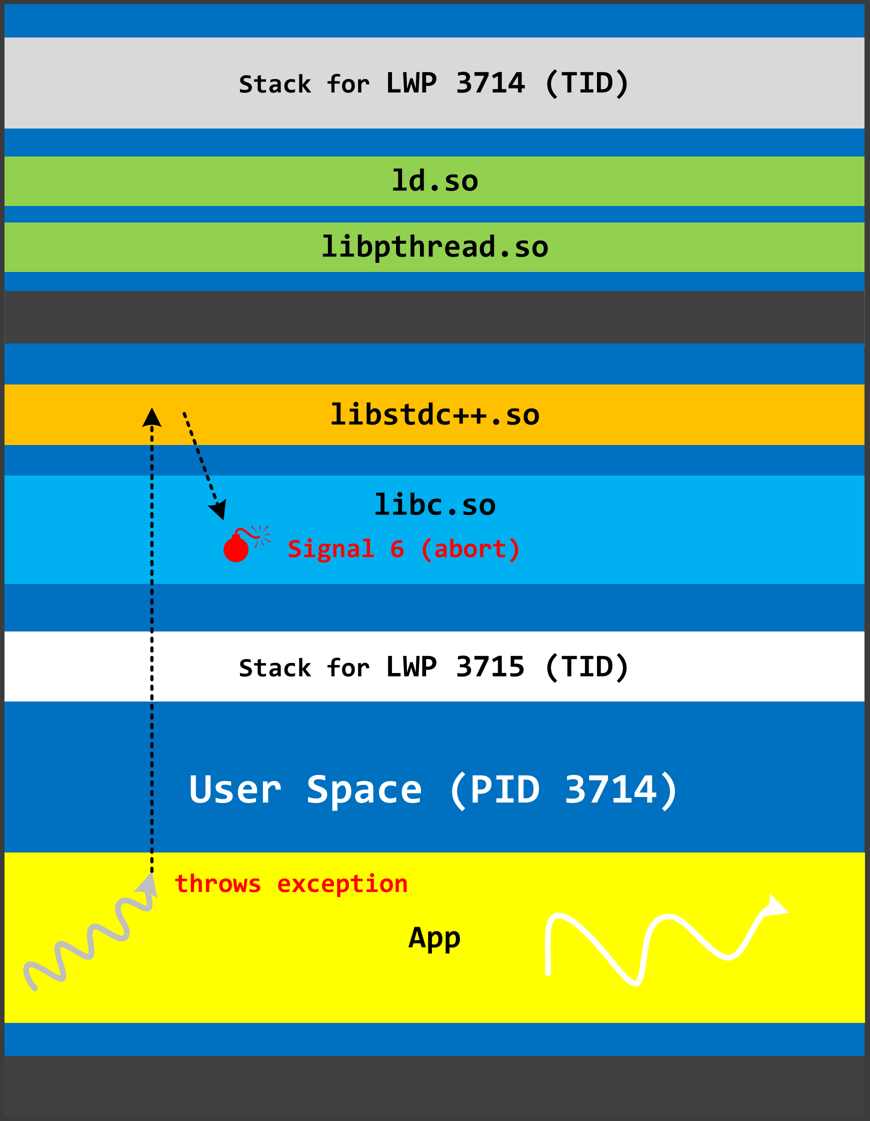
GDB Commands

```
(gdb) x <address>
0x<address>: Cannot access
memory at address 0x<address>
```

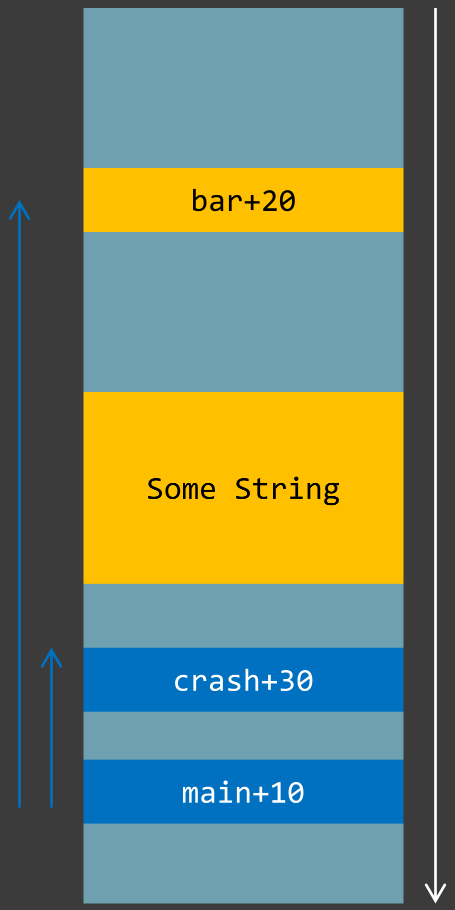
WinDbg Commands

```
0:000> dp <address> L1
<address>  ????????`????????
```

Exceptions (Runtime)



Thread Raw Stack Data



```
void main()
{
      foo();
      crash();
}

void foo()
{
      char sz[256] = “Some String”;
      bar();
}

void bar()
{
      do();
}

void crash()
{
      // ...
}
```

```
(gdb) bt
crash+30
main+10
```

Part 2: x64 Disassembly GDB, LLDB

CPU Registers (x64)

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

GDB Commands

```
info registers
```

WinDbg Commands

```
r
```

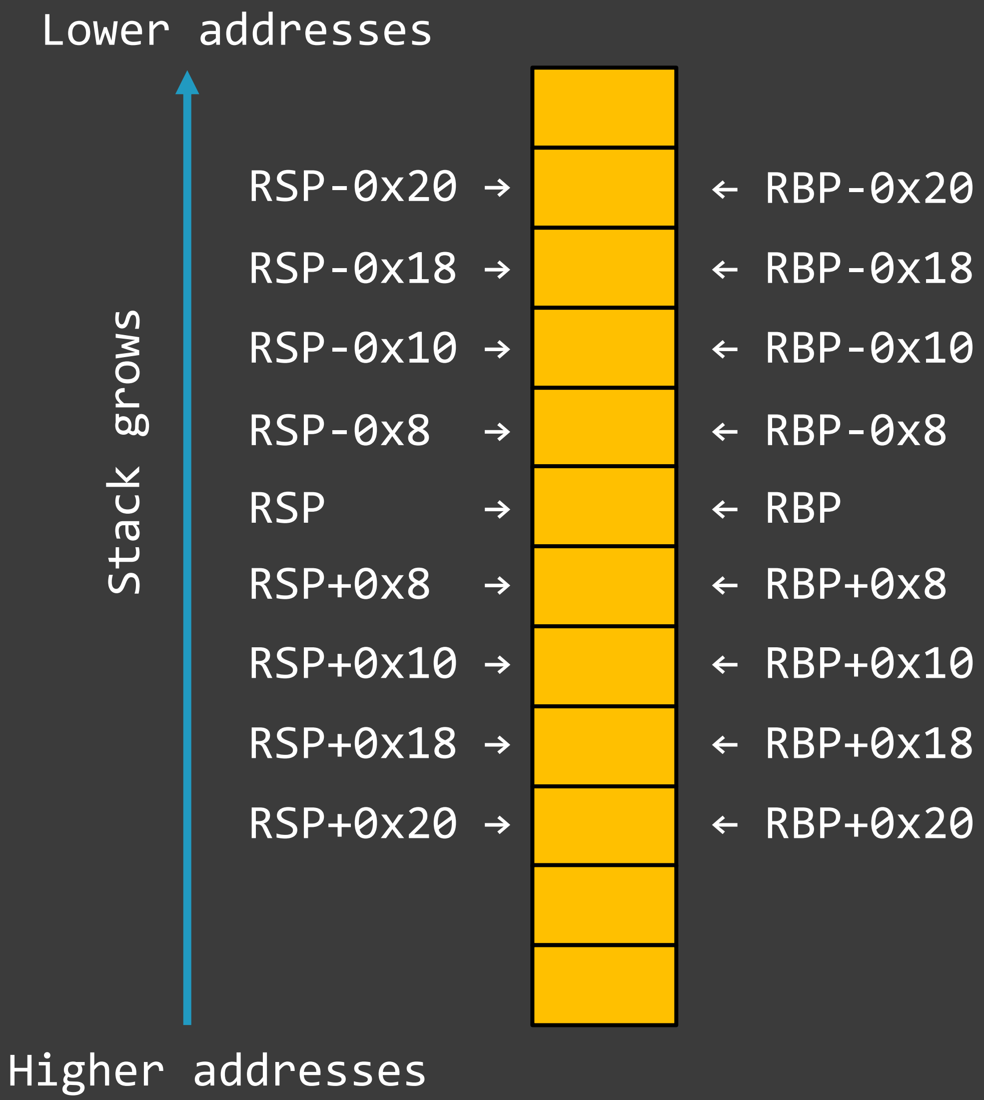
Instructions: registers (x64)

- `Opcode SRC, DST # default AT&T flavour`

- Examples:

```
mov   $0x10, %rax             # 0x10 → RAX
mov   %rsp, %rbp              # RSP → RBP
add   $0x10, %r10             # R10 + 0x10 → R10
imul  %ecx, %edx              # ECX * EDX → EDX
callq *%rdx                   # RDX already contains
                              #    the address of func (&func)
                              # PUSH RIP; &func → RIP
sub   $0x30, %rsp             # RSP-0x30 → RSP
                              # make a room for local variables
```

Memory and Stack Addressing



Lower addresses

Stack grows

RSP-0x20 → ← RBP-0x20
RSP-0x18 → ← RBP-0x18
RSP-0x10 → ← RBP-0x10
RSP-0x8 → ← RBP-0x8
RSP → ← RBP
RSP+0x8 → ← RBP+0x8
RSP+0x10 → ← RBP+0x10
RSP+0x18 → ← RBP+0x18
RSP+0x20 → ← RBP+0x20

Higher addresses

Instructions: memory load (x64)

- `Opcode Offset(SRC), DST`
- `Opcode DST`
- Examples:

```
mov    0x10(%rsp), %rax       # value at address RSP+0x10 → RAX
mov    -0x10(%rbp), %rcx      # value at address RBP-0x10 → RCX
add    (%rax), %rdx           # RDX + value at address RAX → RDX
pop    %rdi                   # value at address RSP → RDI
                              # RSP + 8 → RSP
lea    0x20(%rbp), %r8        # address RBP+0x20 → R8
```

Instructions: memory store (x64)

- `Opcode SRC, Offset(DST)`
- `Opcode SRC|DST`
- Examples:

```
mov    %rcx, -0x20(%rbp)        # RCX → value at address RBP-0x20
addl   $1, (%rax)               # 1 + 32-bit value at address RAX →
                                #     32-bit value at address RAX
push   %rsi                     # RSP - 8 → RSP
                                # RSI → value at address RSP
inc    (%rcx)                   # 1 + value at address RCX →
                                #     value at address RCX
```

Instructions: flow (x64)

- `Opcode DST`
- Examples:

```
jmp     0x10493fc1c         # 0x10493fc1c → RIP
                            # (goto 0x10493fc1c)

call    0x10493ff74         # RSP – 8 → RSP
0x10493fc14:                # 0x10493fc14 → value at address RSP
                            # 0x10493ff74 → RIP
                            # (goto 0x10493ff74)
```

x64 Function Parameters

- `foo(…);`
- Left to right via `RDI`, `RSI`, `RDX`, `RCX`, `R8`, `R9`, stack

Part 3: A64 Disassembly

CPU Registers (A64)

- **X0** – **X28**, **W0** – **W28**
- Stack: **SP**, **X29** (**FP**)
- Next instruction: **PC**
- Link register: **X30** (**LR**)
- Zero register: **XZR**, **WZR**
- 64-bit floating point registers **D0** – **D31**

X 64-bit **W 32-bit**

GDB Commands

```
info registers
```

WinDbg Commands

```
r
```

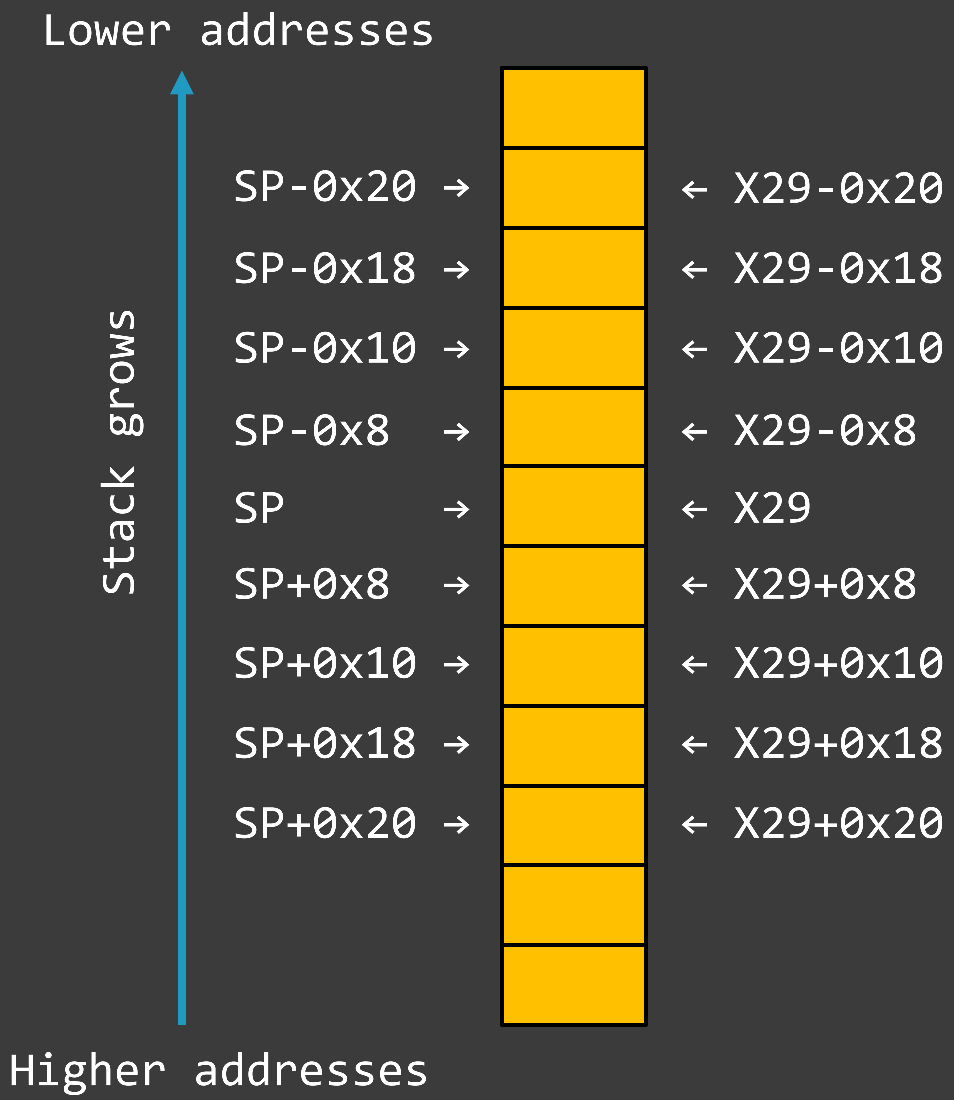
Instructions: registers (A64)

- `Opcode DST, SRC, SRC`$_2$

- Examples:

```
mov    x0, #16                // X0 ← 16 (0x10)
mov    x29, sp                // X29 ← SP
add    x1, x2, #16            // X1 ← X2+16 (0x10)
mul    x1, x2, x3             // X1 ← X2*X3
blr    x8                     // X8 already contains
                              //    the address of func (&func)
                              // LR ← PC+4; PC ← &func
sub    sp, sp, #48            // SP ← SP-48 (-0x30)
                              // make a room for local variables
```

Memory and Stack Addressing



Lower addresses

Stack grows

SP-0x20 → ← X29-0x20

SP-0x18 → ← X29-0x18

SP-0x10 → ← X29-0x10

SP-0x8 → ← X29-0x8

SP → ← X29

SP+0x8 → ← X29+0x8

SP+0x10 → ← X29+0x10

SP+0x18 → ← X29+0x18

SP+0x20 → ← X29+0x20

Higher addresses

Instructions: memory load (A64)

- Opcode DST, DST$_2$, [SRC, Offset]
- Opcode DST, DST$_2$, [SRC], Offset // Postincrement
- Examples:

```
ldr   x0, [sp]              // X0 ← value at address SP+0
ldr   x0, [x29, #-8]        // X0 ← value at address X29-0x8
ldp   x29, x30, [sp, #32]   // X29 ← value at address SP+32 (0x20)
                            // X30 ← value at address SP+40 (0x28)
ldp   x29, x30, [sp], #16   // X29 ← value at address SP+0
                            // X30 ← value at address SP+8
                            // SP ← SP+16 (0x10)
```

Instructions: memory store (A64)

- Opcode SRC, SRC$_2$, [DST, Offset]

- Opcode SRC, SRC$_2$, [DST, Offset]! // Preincrement

- Examples:

```
str   x0, [sp, #16]          // x0 → value at address SP+16 (0x10)
str   x0, [x29, #-8]         // x0 → value at address X29-8
stp   x29, x30, [sp, #32]    // x29 → value at address SP+32 (0x20)
                             // x30 → value at address SP+40 (0x28)
stp   x29, x30, [sp, #-16]!  // SP ← SP-16 (-0x10)
                             // x29 → set value at address SP
                             // x30 → set value at address SP+8
```

Instructions: flow (A64)

- `Opcode DST, SRC`
- Examples:

```
adrp  x0, 0x420000        // x0 ← 0x420000

b     0x10493fc1c         // PC ← 0x10493fc1c
                          // (goto 0x10493fc1c)
br    x17                 // PC ← the value of X17

0x10493fc14:              // PC == 0x10493fc14
bl    0x10493ff74         // LR ← PC+4 (0x10493fc18)
                          // PC ← 0x10493ff74
                          // (goto 0x10493ff74)
```

A64 Function Parameters

- `foo(…);`
- Left to right via `X0 - X7`, `[SP]`, `[SP+8]`, `[SP+16]`, `...`

Part 4: x64 Disassembly WinDbg

CPU Registers (x64)

- **RAX** ⊃ **EAX** ⊃ **AX** ⊇ {**AH**, **AL**}

RAX 64-bit **EAX 32-bit**

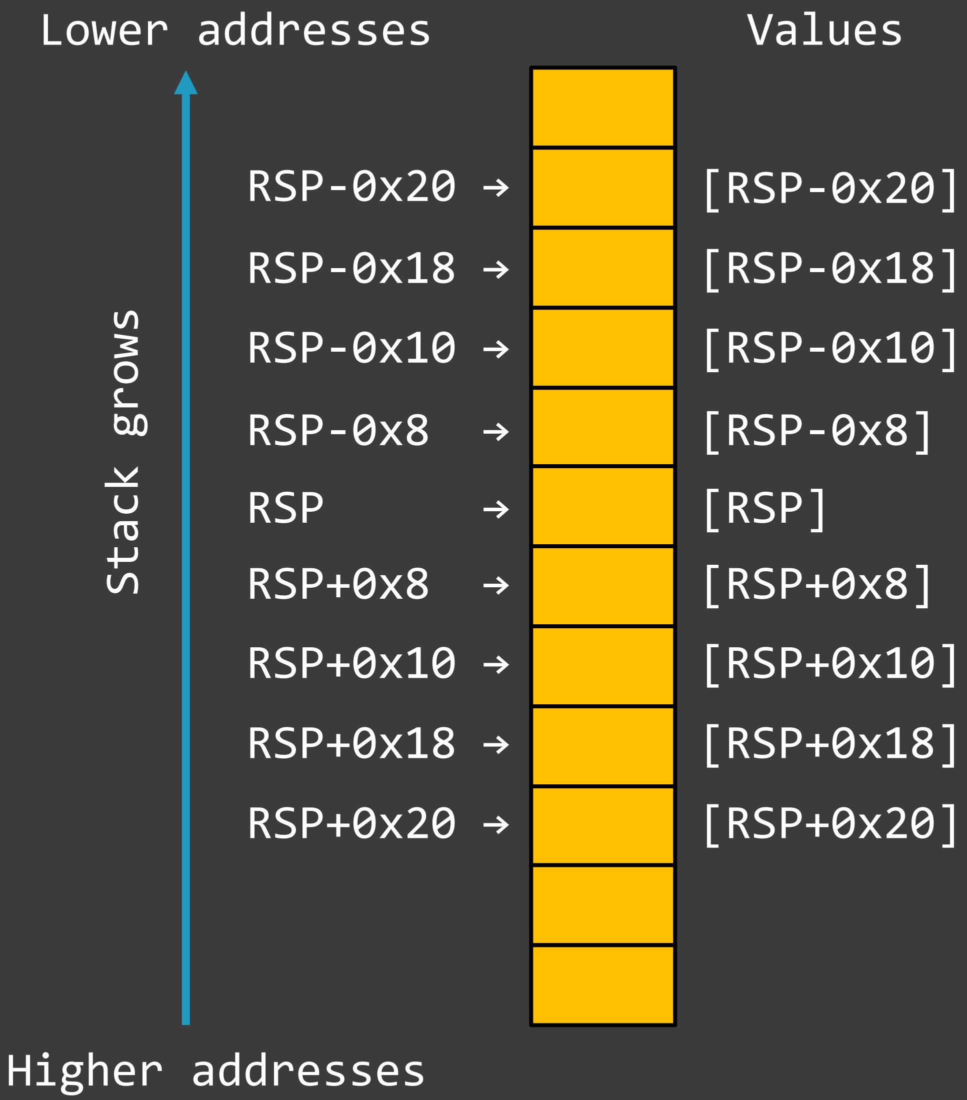
- ALU: **RAX**, **RDX**
- Counter: **RCX**
- Memory copy: **RSI** (src), **RDI** (dst)
- Stack: **RSP**, **RBP**
- Next instruction: **RIP**
- New: **R8** – **R15**, **Rx**(**D**|**W**|**B**)

Instructions and Registers (x64)

- `Opcode DST, SRC`
- Examples:

```
mov   rax, 10h              ; RAX ← 0x10
mov   r13, rdx              ; R13 ← RDX
add   r10, 10h              ; R10 ← R10 + 0x10
imul  edx, ecx              ; EDX ← EDX * ECX
call  rdx                   ; RDX already contains
                            ;    the address of func (&func)
                            ; PUSH RIP; RIP ← &func
sub   rsp, 30h              ; RSP ← RSP-0x30
                            ; make room for local variables
```

Memory and Stack Addressing



Lower addresses

Values

Stack grows

RSP-0x20 → [RSP-0x20]

RSP-0x18 → [RSP-0x18]

RSP-0x10 → [RSP-0x10]

RSP-0x8 → [RSP-0x8]

RSP → [RSP]

RSP+0x8 → [RSP+0x8]

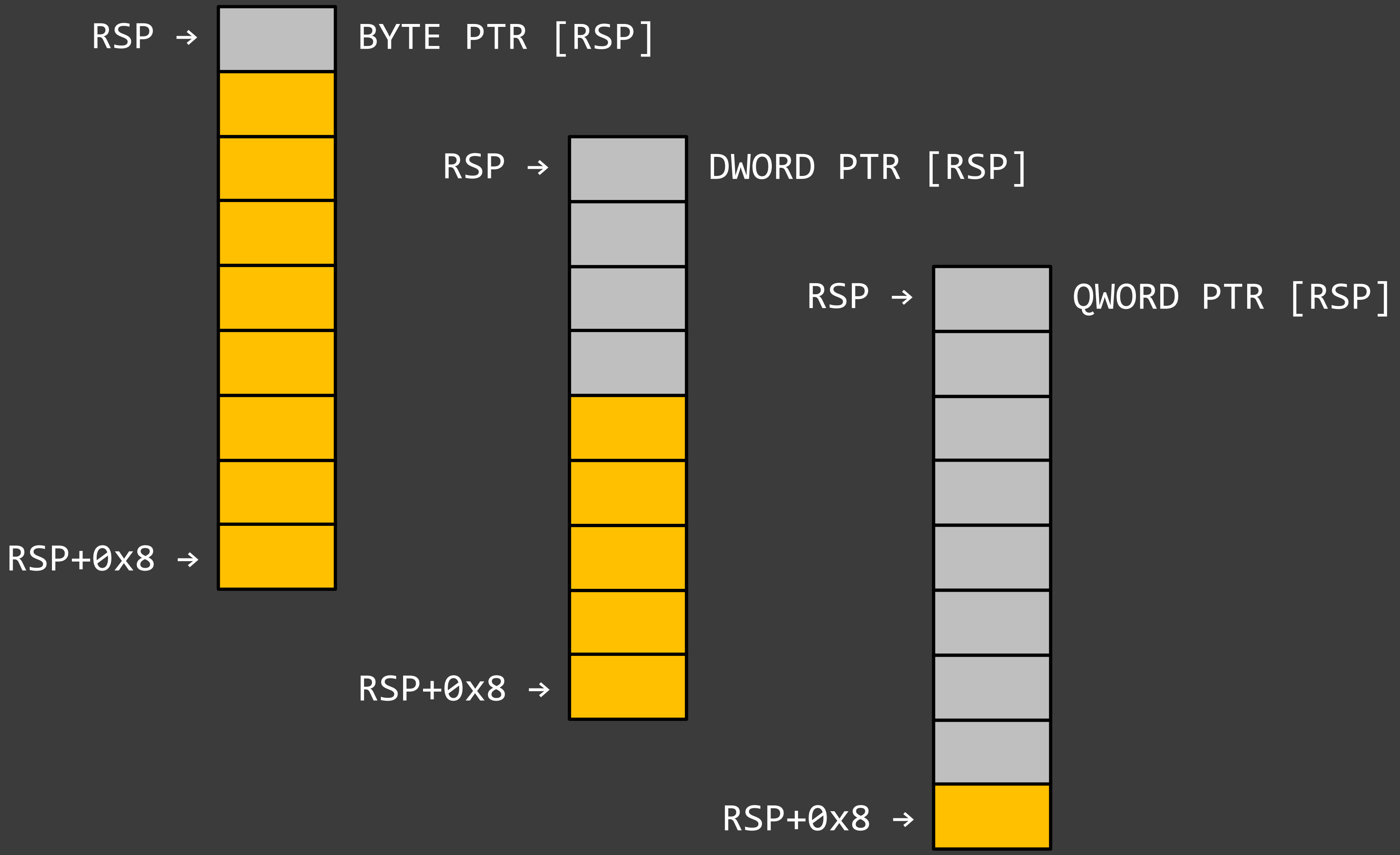
RSP+0x10 → [RSP+0x10]

RSP+0x18 → [RSP+0x18]

RSP+0x20 → [RSP+0x20]

Higher addresses

Memory Cell Sizes



Memory Load Instructions (x64)

- `Opcode DST, PTR [SRC+Offset]`
- `Opcode DST`
- Examples:

```
mov    rax, qword ptr [rsp+10h] ; RAX ←
                                ; 64-bit value at address RSP+0x10
mov    ecx, dword ptr [20]      ; ECX ←
                                ; 32-bit value at address 0x20
pop    rdi                      ; RDI ← value at address RSP
                                ; RSP ← RSP + 8
lea    r8, [rsp+20h]            ; R8 ← address RSP+0x20
```

Memory Store Instructions (x64)

- `Opcode PTR [DST+Offset], SRC`
- `Opcode DST|SRC`
- Examples:

```
mov    qword ptr [rbp-20h], rcx ; 64-bit value at address RBP-0x20
                                ;   ← RCX
mov    byte ptr [0], 1          ; 8-bit value at address 0 ← 1
push   rsi                      ; RSP ← RSP - 8
                                ; value at address RSP ← RSI
inc    dword ptr [rcx]          ; 32-bit value at address RCX ←
                                ;   1 + 32-bit value at address RCX
```

Flow Instructions (x64)

- `Opcode DST`
- `Opcode PTR [DST]`
- Examples:

```
jmp    00007ff6`9ef2f008    ; RIP ← 0x7ff69ef2f008
                            ; (goto 0x7ff69ef2f008)
jmp    qword ptr [rax+10h] ; RIP ← value at address RAX+0x10
call   00007ff6`9ef21400    ; RSP ← RSP – 8
00007ff6`9ef21057:          ; value at address RSP ← 0x7ff69ef21057
                            ; RIP ← 0x7ff69ef21400
                            ; (goto 0x7ff69ef21400)
```

Function Parameters (x64)

- `foo(…);`
- Left to right via `RDI`, `RSI`, `RDX`, `RCX`, `R8`, `R9`, stack

`Args to Child` are not parameters

WinDbg Commands

```
0:000> kv
 # Child-SP    RetAddr    : Args to Child    : Call Site
…
```

Part 5: Practice Exercises

Links

- Applications:

Download links are in every exercise.

- Exercise Transcripts:

Included in this book.

Warning

Because of live debugging, due to differences in actual systems and ASLR (Address Space Layout Randomization), when you launch applications, actual addresses and even the number and order of threads in WinDbg, GDB, and LLDB command output may differ from those shown in exercise transcripts.

Exercise UD0

- **Goal:** Download and verify GDB, LLDB, and WinDbg installations
- **Memory Analysis Patterns:** Stack Trace
- \ALD4\Exercise-Linux-UD0.pdf

User Mode Debugging

Exercises UD1 – UD7

Exercise UD1

- **Goal:** Learn how code generation parameters can influence process execution behavior
- **Elementary Diagnostics Patterns:** Crash
- **Memory Analysis Patterns:** Exception Stack Trace; NULL Pointer (Code); Constant Subtrace
- **Debugging Implementation Patterns:** Break-in; Scope; Variable Value; Type Structure; Code Breakpoint
- \ALD4\Exercise-Linux-UD1.pdf

Code Breakpoints

GDB Commands

```
break <name>
info break
delete break <number>
```

WinDbg Commands

```
bp <name>
bl
bc <number>
```

LLDB Commands

```
break set -name <name>
break list
break delete <number>
```

Exercise UD2

- **Goal:** Learn how to use hardware breakpoints to catch data corruption
- **Elementary Diagnostics Patterns:** Counter Value
- **Memory Analysis Patterns:** Unloaded Module; Memory Leak (Process Heap); Corrupt Structure; Abnormal Value (*from trace analysis patterns*)
- **Debugging Implementation Patterns:** Break-in; Code Breakpoint; Scope; Variable Value; Data Breakpoint
- \ALD4\Exercise-Linux-UD2.pdf

Data Breakpoints

GDB Commands

```
watch *<address>
info break
delete break <number>
```

LLDB Commands

```
watch set expression -- <address>
watch list
watch delete <number>
```

Exercise UD3

- **Goal:** Learn how to navigate parameters, static and local variables, and data structures
- **Elementary Diagnostics Patterns:** Crash
- **Memory Analysis Patterns:** Exception Stack Trace; Stack Overflow (User Mode); String Parameter; Module Variable
- **Debugging Implementation Patterns:** Break-in; Scope; Variable Value; Type Structure
- \ALD4\Exercise-Linux-UD3.pdf

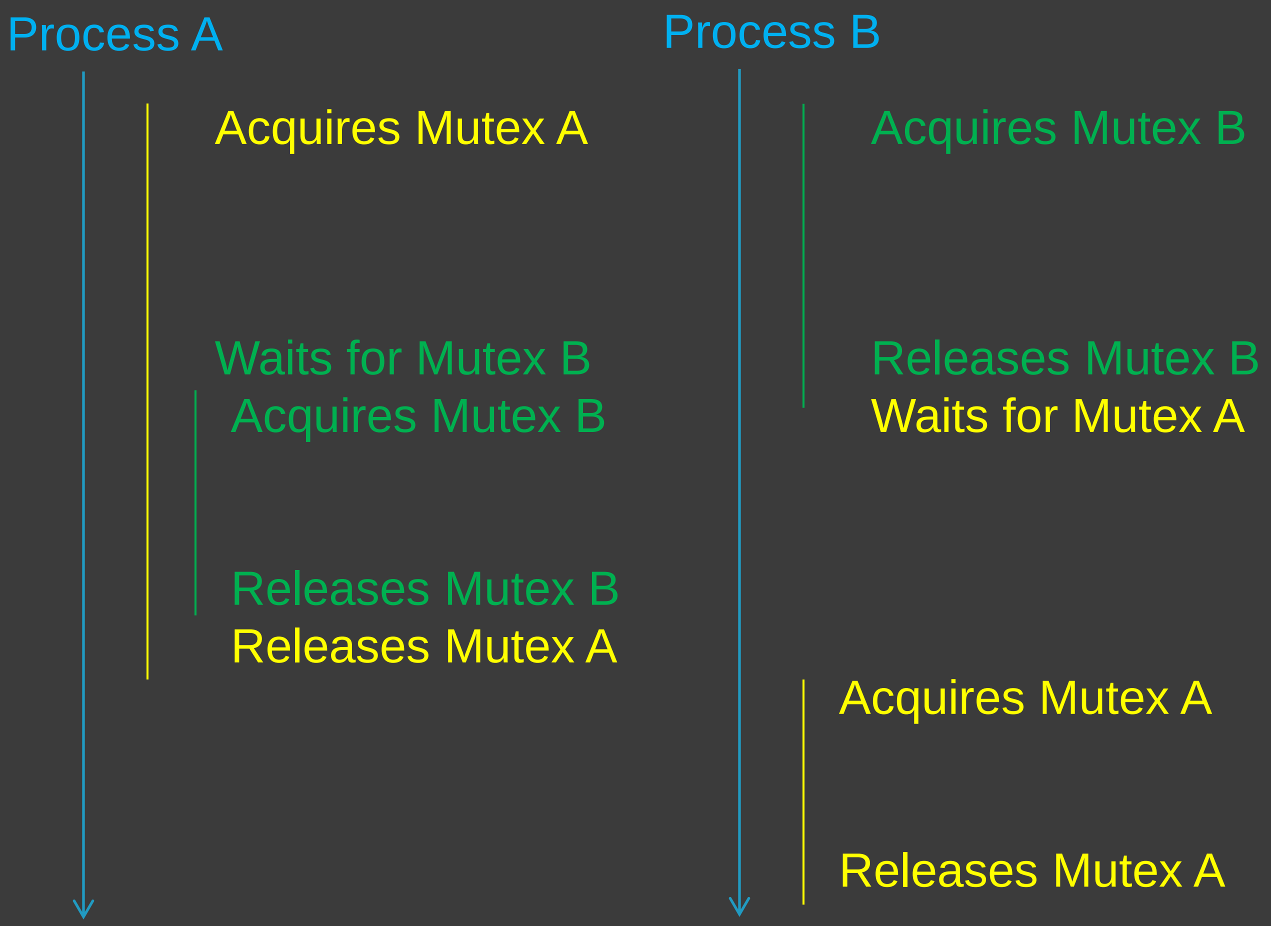
Exercise UD4

- **Goal:** Learn how to use conditional breakpoints to log behavior
- **Elementary Diagnostics Patterns:** Use-case Deviation
- **Memory Analysis Patterns:** -
- **Debugging Implementation Patterns:** Break-in; Code Breakpoint; Breakpoint Action
- \ALD4\Exercise-Linux-UD4.pdf

Exercise UD5

- **Goal:** Learn how to debug multiple processes and their deadlock
- **Elementary Diagnostics Patterns:** Crash; Hang
- **Memory Analysis Patterns:** Exception Stack Trace; Constant Subtrace; NULL Pointer (Data); Main Thread; Execution Residue (Unmanaged Space, User); C++ Exception; Hidden Exception (User Space); Handled Exception (User Space); Wait Chain (Mutex Objects); Deadlock (Objects, User Space); Coincidental Symbolic Information; Function Pointer
- **Debugging Implementation Patterns:** Break-in
- \ALD4\Exercise-Linux-UD5.pdf

Expected Behavior



Process A

Acquires Mutex A

Waits for Mutex B

Acquires Mutex B

Releases Mutex B

Releases Mutex A

Process B

Acquires Mutex B

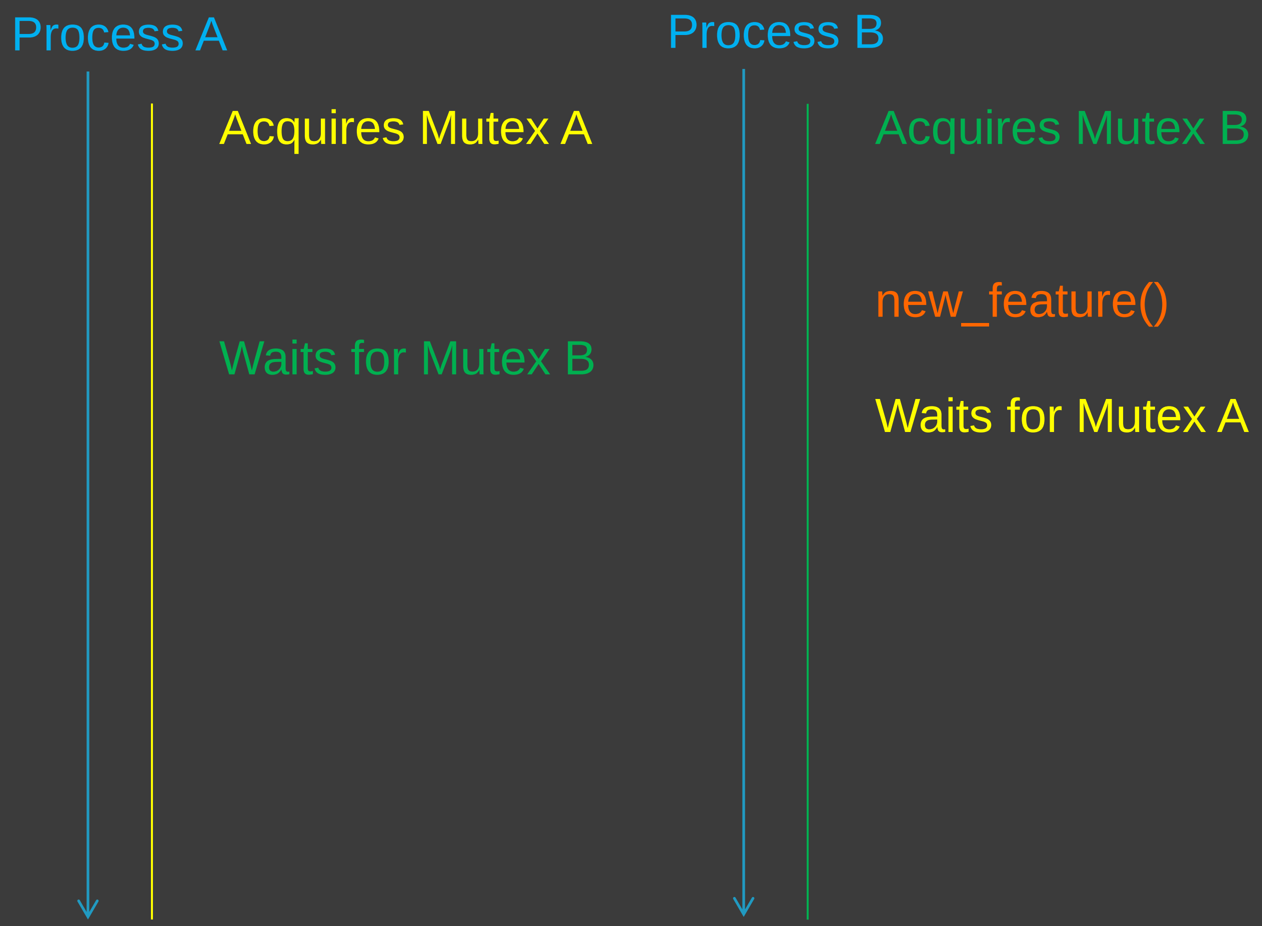
Releases Mutex B

Waits for Mutex A

Acquires Mutex A

Releases Mutex A

Deadlock



Process A

Acquires Mutex A

Waits for Mutex B

Process B

Acquires Mutex B

new_feature()

Waits for Mutex A

Exercise UD6

- **Goal:** Learn how to recognize when we need kernel-level debugging
- **Elementary Diagnostics Patterns:** Hang; Counter Value
- **Memory Analysis Patterns:** Abnormal Value (*from trace analysis patterns*); Spiking Thread
- **Debugging Implementation Patterns:** Break-in; Code Breakpoint; Data Breakpoint; Code Trace
- \ALD4\Exercise-Linux-UD6.pdf

Exercise UD7

- **Goal:** Learn how to manipulate threads to debug race conditions
- **Elementary Diagnostics Patterns:** Crash
- **Memory Analysis Patterns:** Exception Stack Trace; NULL Pointer (Code)
- **Debugging Implementation Patterns:** Frozen Thread
- \ALD4\Exercise-Linux-UD7.pdf

Kernel Mode Debugging

Exercises KD8, KD10

Exercise KD0

- **Goal:** Set up Hyper-V kernel debugging environment
- \ALD4\Exercise-Linux-KD0.pdf

Exercise KD8

- **Goal:** Learn how to navigate kernel space using KDB
- **Elementary Diagnostics Patterns:** -
- **Memory Analysis Patterns:** Stack Trace; Stack Trace Collection (Unmanaged Space); Stack Trace Collection (CPUs); Module Collection; Execution Residue (Unmanaged Space, Kernel)
- **Debugging Implementation Patterns:** Code Breakpoint
- \ALD4\Exercise-Linux-KD8.pdf

Exercise KD10

- **Goal:** Learn how to configure and build Linux kernel and use GDB for kernel-level debugging
- **Elementary Diagnostics Patterns:** -
- **Memory Analysis Patterns:** Stack Trace
- **Debugging Implementation Patterns:** Code Breakpoint
- \ALD4\Exercise-Linux-KD10.pdf

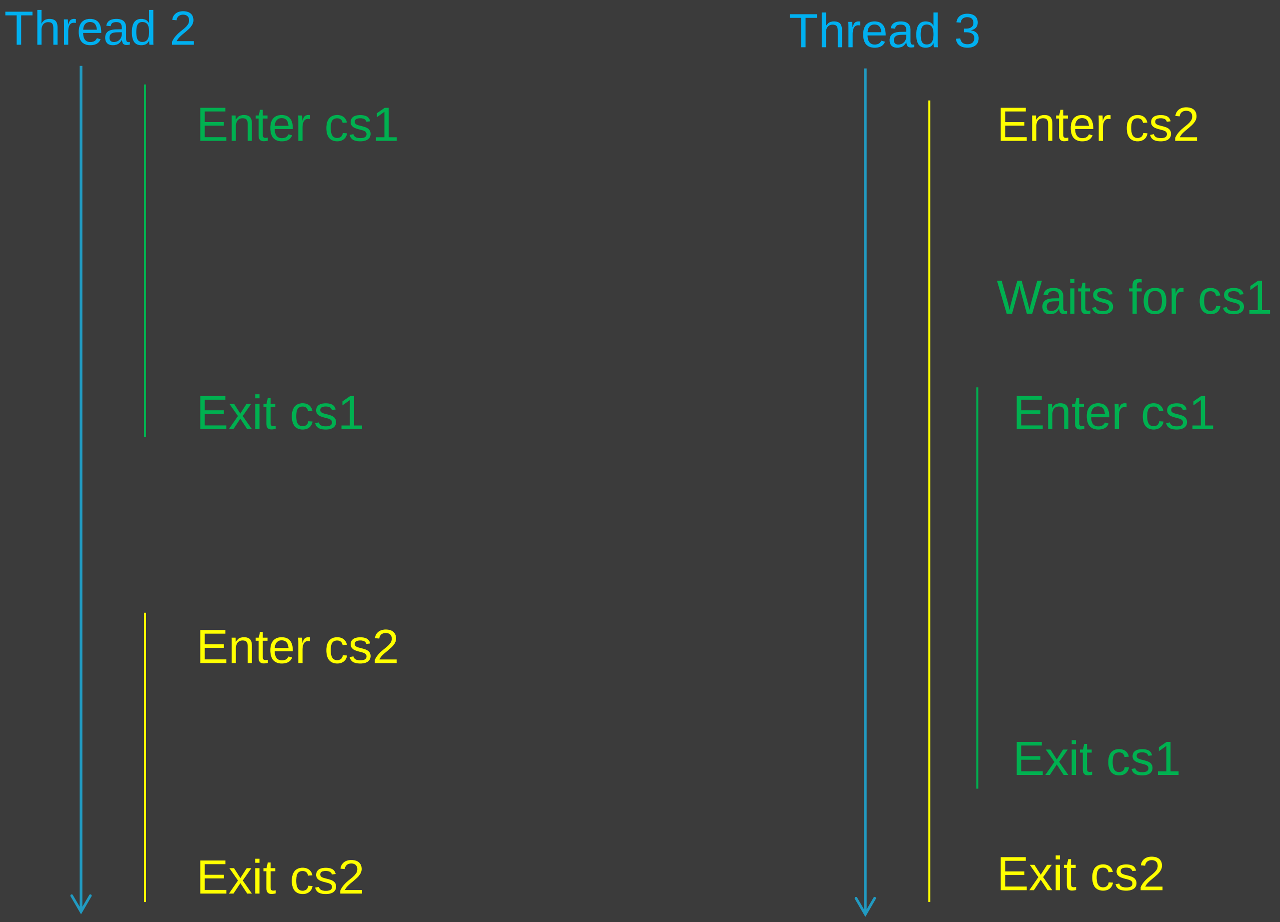
Managed Debugging

Exercise MD9

Exercise MD9

- **Goal:** Learn how to debug Python code using GDB
- **Elementary Diagnostics Patterns:** Hang
- **Memory Analysis Patterns:** Stack Trace Collection (Unmanaged Space); Stack Trace Collection (Managed Space); Runtime Thread (Python, Linux); Managed Stack Trace (Python); Pointer Cone; Deadlock (Managed Space)
- **Debugging Implementation Patterns:** Break-in
- \ALD4\Exercise-Linux-MD9.pdf

Expected Behavior



Thread 2

Enter cs1

Exit cs1

Enter cs2

Exit cs2

Thread 3

Enter cs2

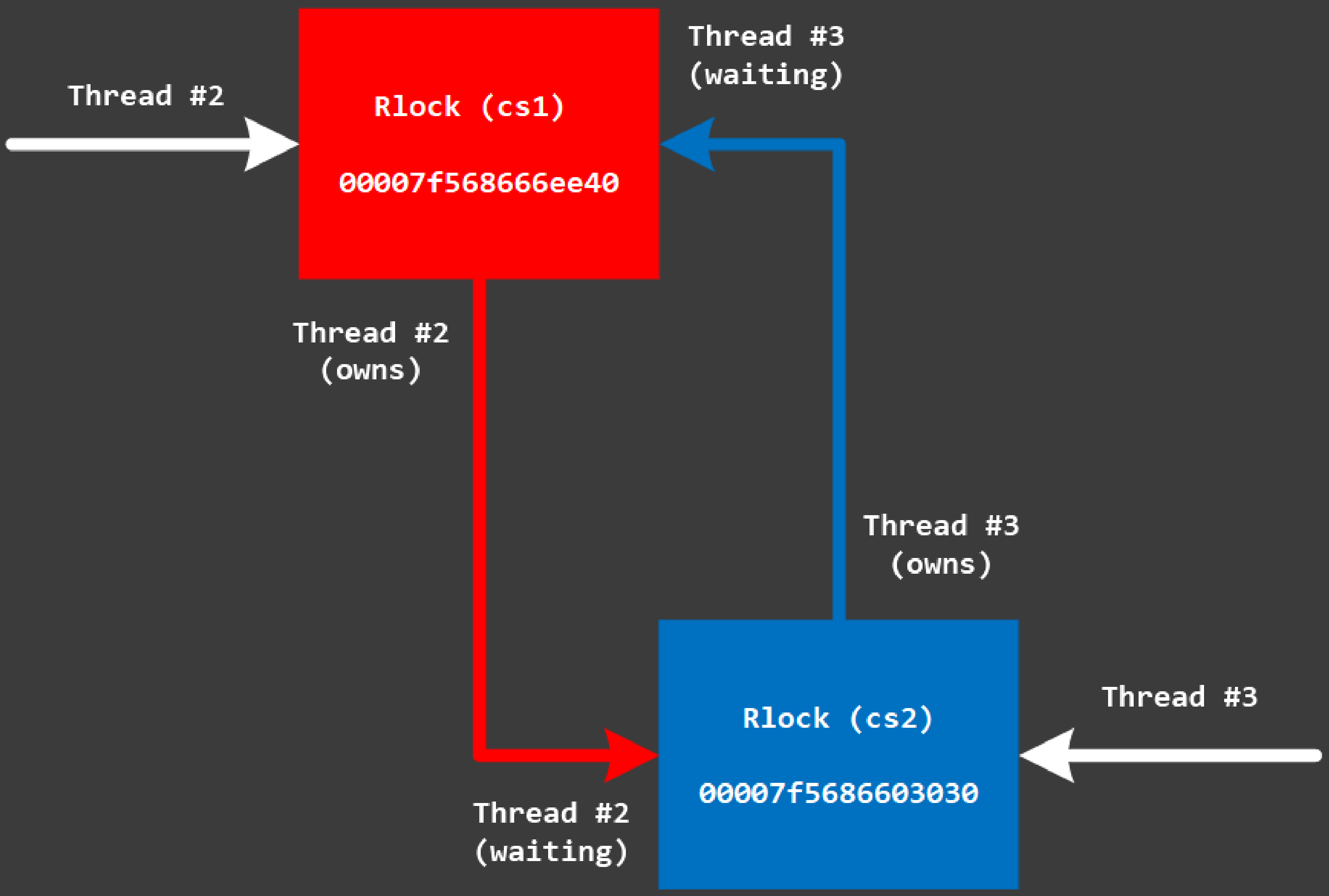
Waits for cs1

Enter cs1

Exit cs1

Exit cs2

Deadlock



Thread #2

Rlock (cs1)

00007f568666ee40

Thread #3
(waiting)

Thread #2
(owns)

Thread #3
(owns)

Rlock (cs2)

00007f5686603030

Thread #3

Thread #2
(waiting)

Time Travel Debugging

Exercise TD5

Exercise TD5

- **Goal:** Learn how to find hidden exceptions using Time Travel Debugging

- **Elementary Diagnostics Patterns:** Hang

- **Memory Analysis Patterns:** C++ Exception; Hidden Exception (User Space)

- **Debugging Implementation Patterns:** Instruction Trace

- \ALD4\Exercise-Linux-TD5.pdf

Rust Debugging

Exercise RD11

Exercise RD11

- **Goal:** Learn how WinDbg, GDB, and LLDB can be used to debug Rust applications
- **Elementary Diagnostics Patterns:** Error Message
- **Memory Analysis Patterns:** Stack Trace
- **Debugging Implementation Patterns:** Break-in; Code Breakpoint; Scope; Variable Value; Type Structure
- \ALD4\Exercise-Linux-RD11.pdf

Postmortem Debugging

- Accelerated Linux Core Dump Analysis, Third Edition (PDF book + Recording)
- Accelerated Linux Core Dump Analysis (Educative course)

Additional Training for Debugging

- Accelerated Linux API for Software Diagnostics
- Accelerated C & C++ for Linux Diagnostics
- Accelerated Linux Disassembly, Reconstruction and Reversing, Second Edition
- Memory Thinking for Rust
- Foundations of Linux Debugging, Disassembling, and Reversing
- Debugging, Disassembly & Reversing in Linux for x64 Architecture (Educative course)
- Foundations of ARM64 Linux Debugging, Disassembling, and Reversing
- Foundations of Linux ARM64: Debug, Disassemble, and Reverse (Educative course)

Resources

- DumpAnalysis.org / SoftwareDiagnostics.Institute / PatternDiagnostics.com
- Debugging.TV / YouTube.com/DebuggingTV / YouTube.com/PatternDiagnostics
- Software Diagnostics Library
- Pattern-Driven Software Problem Solving
- Encyclopedia of Crash Dump Analysis Patterns, Third Edition
- Memory Dump Analysis Anthology (Diagnomicon)

Q&A

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

Thank you for attendance!