Targeted Memory Runtime Analysis

David Piché

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Polytechnique Montreal

DORSAL Laboratory

Agenda

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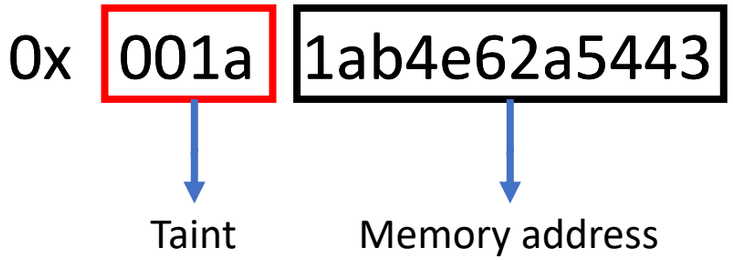
Introduction

- Memory issues in C/C++ are still prevalent
  - Use-after-free
  - Memory leaks
  - Out-of-bound writes
  - And much more…

Previous Work

- X86_64 architecture
- Minimal approach to recreate datawatch:
  - Overwrite the *malloc/realloc* to add a taint.
  - Tainted pointers: use bits 47 to 63 for pointer tainting.



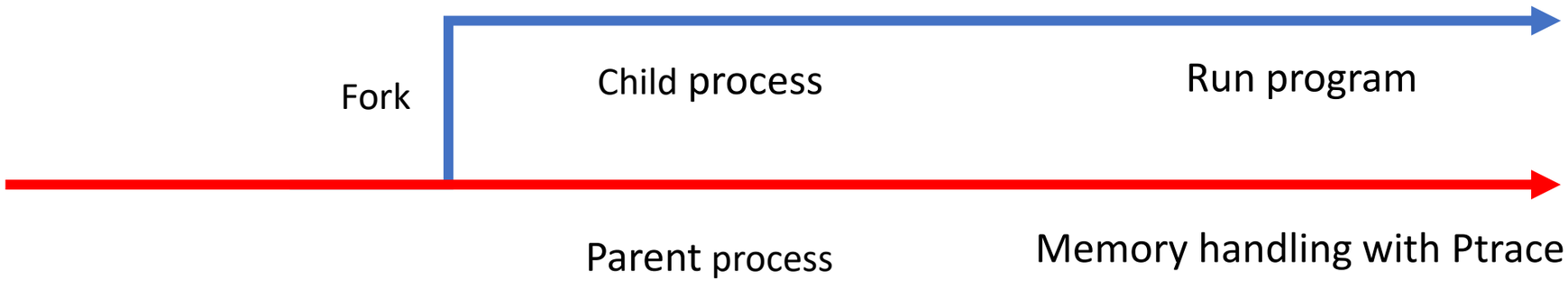
Our general approach: Memory Handler

- For each memory access, we need to:
  - Use a signal handler (SIGSEGV, SIGBUS…)
  - Identify the right register with the tainted address
    - Disassemble using capstone
  - Do bounds checking
  - Un-taint the address
  - Execute the faulty instruction
  - Re-taint the address

- How can we do those last 2 steps?

Our general approach: Ptrace

- Use Ptrace with 2 different processes
  - The child process runs the program with the special allocators
  - The parent process takes care of memory handling
  - Ptrace used for communication between processes and single-step



Our general approach: Ptrace

- 2 processes do not share the same virtual memory!
- We need to do multiple Ptrace PEEKDATA calls with each tainted memory access
- Additional overhead!

Our general approach: Ptrace and shared virtual memory

- Using clone() instead of fork(), we can use the same virtual memory for the two processes (CLONE_VM)

- Less overhead, as the Ptrace PEEKDATA calls are no longer needed

- Ongoing development

Our general approach: Instruction emulation

- Using Olivier's Libpatch, we can directly emulate the instructions
- Reduces significantly the need for signal handling
- Ongoing development

Result: Overhead

- For each tainted memory access, the approach with Ptrace needs ~100µs.
- With the Ptrace with clone() approach, we can remove multiple Ptrace PEEKDATA calls per memory access (each being ~2µs).
- With libpatch, performance improved, as we only have to call the special handler once for each tainted address.

Future Works

- Use the upper 16 bits to store useful information:
  - Object id: identify objects more prone to memory errors
  - Use tags instead of object ids

- **Targeted** memory analysis
  - Taint some memory allocations based on parameters (size?)