Virtuozzo

Painless Live Userspace Patching

https://github.com/skinsbursky/presentations/blob/master/lup-devconf.odp

Stanislav Kinsburskiy

Summary

- What is “Live Patching”?
- Why it's needed?
- Types of binary code
- Process state
- What can be patched?
- Binary patch creation
- When binary patch can be applied?
- Where to place new code?
- Userspace live patching in pictures
- Why is it called “painless”?

What is “Live Patching”?

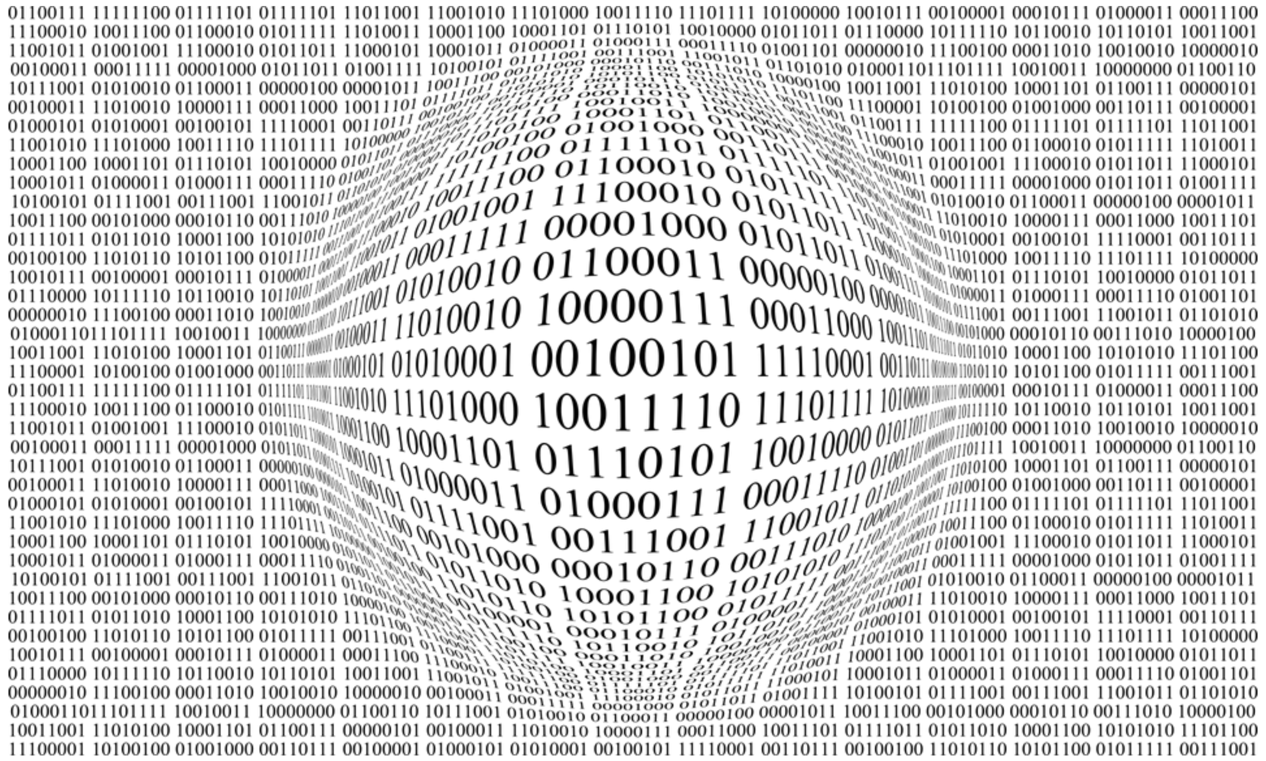
- Change a piece of code in a process
- Preserve process state
- Do it safe

Why it's needed?

- Get rid of heavy services restart
- Reduce service downtime in case of critical vulnerabilities, because of:
  - No need in application restart
  - No need in migration

Types of binary code

- Statically-linked
- Dynamically-linked
  - Load-time relocation
  - Position independent code (PIC)



Process state

- Process state is like a cards castle:
  - strongly associated
  - accurately verified
- Contains of:
  - statically allocated variables
  - dynamically allocated variables
  - stack content
- Is changing during runtime

What can be patched?

- Not any binary patch can be applied
- Fundamental Limitations:
  - Static data of different size
  - Dynamically allocated objects of different size
- Source code review is required :(

Binary patch creation

- Information about binary is required
- Patch code on function basis:
  - Reliable
  - Relatively simple
- Information about symbols required:
  - Name
  - Size
  - Address

When binary patch can be applied?

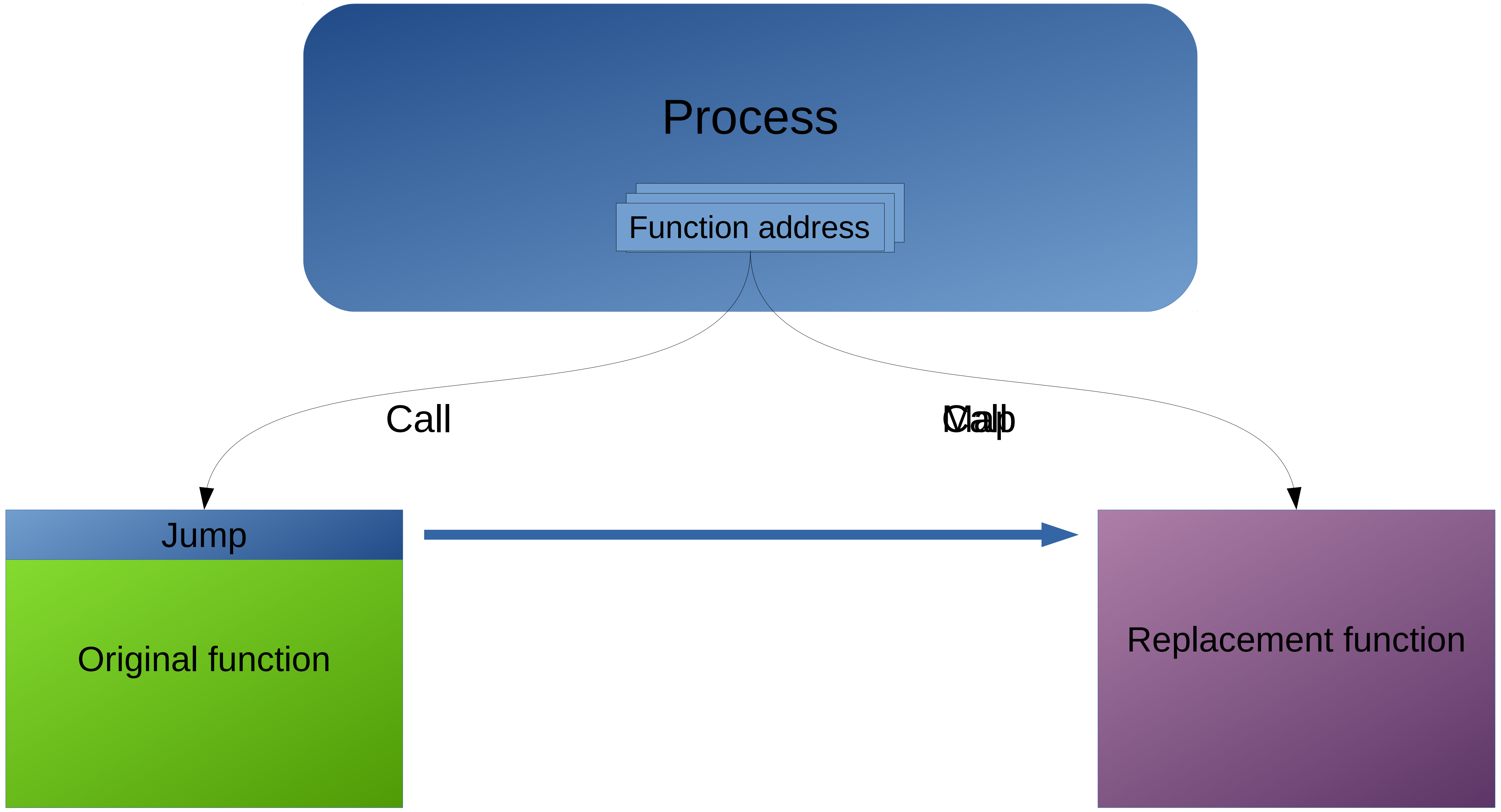
- Process external stop/resume is essential
- Not at any moment of time:
  - Process can execute the code to patch
  - Code to patch can be referenced in the call stack
- Stack unwinding is essential:
  - Need to catch the process outside old code
  - Or at least outside functions to patch

Where to place new code?

- Has to be placed into process address space:
  - Either as binary blob
  - Or as a file mapping
- Static code has to be “fixed” in place
- PIC code can be mapped as is, but:
  - Initialization required: external and global symbols
  - Corresponding data has to be copied
- Need to redirect execution to the new code

Userspace live patching in pictures

Before patching
Patching
via address replace
via jump



Why is it called “painless”?

- Live patching can't be painless :)
- No kernel changes!
- Binary patch creation can be based on ELF parsing
- Libcompel can be used for:
  - Task stop
  - Task resume
  - Code insertion
  - Source: https://github.com/xemul/criu/tree/criu-dev
- Libunwind can be used for stack unwinding
  - Source: http://git.savannah.gnu.org/cgit/libunwind.git

Thanks for your attention. Q&A.

https://github.com/skinsbursky/presentations/blob/master/lup-devconf.odp