

The background of the slide features a dark, textured surface on the left, transitioning into a red-tinted image of server racks on the right. The racks have a perforated metal mesh and some glowing red lights. The Virtuozzo logo is positioned in the top left corner.

Virtuozzo

Painless Live Userspace Patching

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

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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)

01100111 11111100 01111101 01111101 11011001 11001010 11101000 10011110 11101111 10100000 10010111 00100001 00010111 01000011 00011100
11100010 10011100 01100010 01011111 11010011 10001100 10001101 01110101 10010000 01011011 01110000 10111110 10110010 10110101 10011001
11001011 01001001 11100010 01011011 11000101 10001011 01111001 00111001 11001011 01001010 01000010 11100100 00011010 10010010 10000010
00100011 00011111 00001000 01011011 01001111 10100101 01111001 00111001 11001011 01001010 01000100 11101111 10010011 10000000 01100110
10111001 01010010 01100011 00000100 00001011 10011101 00011001 10001101 01001010 01000100 10011001 11010100 10001101 01100111 00000101
00100011 11010010 10000111 00011000 10011101 00111001 00011001 10001101 01001010 01000100 10011001 11100001 10100100 01001000 00110111 00100001
01000101 01010001 00100101 11100001 00110111 00100101 00011001 10001101 01001010 01000100 10011001 11111100 01111011 01111011 11011001
11001010 11101000 10011110 11101111 10100000 10001101 01001010 01000100 10011001 11100001 10011100 01100010 01011111 11010011
10001100 10001101 01110101 10010000 01011011 11000101 01001010 11100010 01011011 10001101 01001001 11100010 01011011 10001101
10001011 01000011 01000111 00011110 01001011 11111100 01100010 01011101 10001101 01001010 01000100 11100010 01011011 10001101
10100101 01111001 00111001 11001011 01001011 11111100 01100010 01011101 10001101 01001010 01000100 11100010 01011011 10001101
10011000 00101000 00010110 00111010 10001101 11111100 01100010 01011101 10001101 01001010 01000100 11100010 01011011 10001101
01111011 01011010 10001100 10101010 11101111 10001101 01001011 11111100 01100010 01011101 10001101 01001010 01000100 11100010 01011011
00100100 11010110 10101100 01011111 00011001 11100010 01011101 10001101 01001010 01000100 11100010 01011011 10001101 01001010 01000100
10010111 00100001 00010111 01000011 00000100 00000100 00000100 00000100 00000100 00000100 00000100 00000100 00000100 00000100 00000100
01110000 10111110 10110010 10101010 10101010 10101010 10101010 10101010 10101010 10101010 10101010 10101010 10101010 10101010 10101010
00000010 11100100 00011010 10010010 10000000 10011001 10001101 10001101 10001101 10001101 10001101 10001101 10001101 10001101 10001101
010001101110111 10010011 10000000 10011001 10001101 10001101 10001101 10001101 10001101 10001101 10001101 10001101 10001101 10001101 10001101
10011001 11010100 10001101 00110011 00000101 01000011 01010001 00100101 11100011 10011001 10001101 10001101 10001101 10001101 10001101
11100001 10100100 01001000 00110111 00100001 01000101 01010001 00100101 11110001 00110111 00100100 11010110 10101100 01011111 00111001
01100010 10011100 01100010 01011111 10001101 11101000 10011110 11101111 10100000 01011001 10001101 10001101 10001101 10001101 10001101
00100011 00011111 00001000 01011001 10001101 10001101 10001101 10001101 10001101 10001101 10001101 10001101 10001101 10001101 10001101
10111001 01010010 01100011 00000100 00000100 00000100 00000100 00000100 00000100 00000100 00000100 00000100 00000100 00000100 00000100
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00000010 11100100 00011010 10010010 10000010 00100011 00011111 10001101 10001101 10001101 10001101 10001101 10001101 10001101 10001101
010001101110111 10011001 10000000 01100110 10111001 01010010 01100011 00000100 00000101 10011100 00101000 00001010 00111010 10000100
10011001 11010100 10001101 01100111 00000101 01000011 11010010 10000111 00011000 10011011 01111011 01011010 10001100 10101010 11101100
11100001 10100100 01001000 00110111 00100001 01000101 01010001 00100101 11110001 00110111 00100100 11010110 10101100 01011111 00111001

Process state

- Process state is like a cards castle:
 - strongly associated
 - accurately verified
- Contains:
 - statically allocated variables
 - dynamically allocated variables
 - stack content
- Changes 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

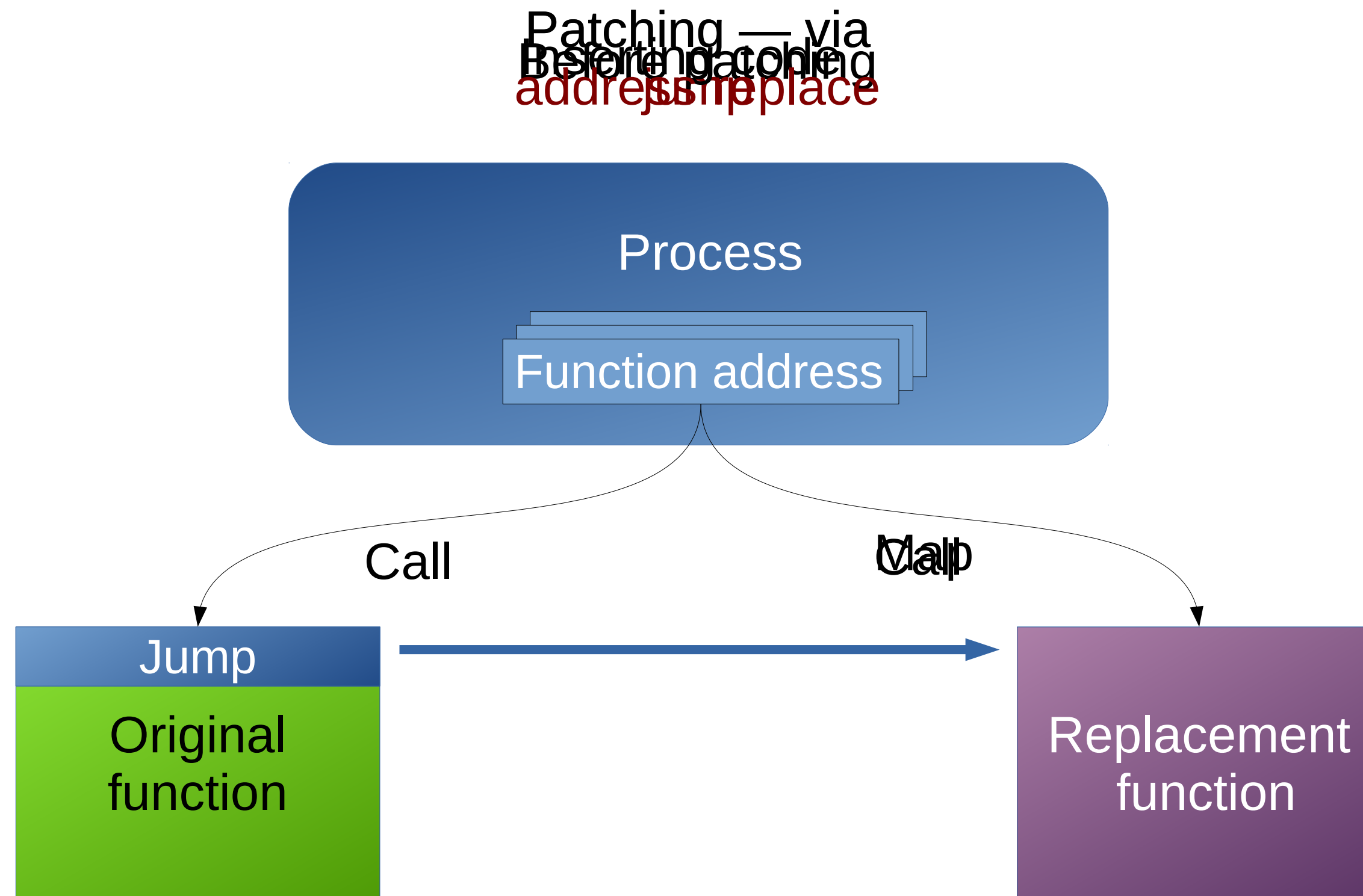


Where to place new code?

- 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



Why is it called “painless”?

- Live patching can't be painless :)
- No kernel changes required!
- 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>



The background of the slide is a photograph of a server room aisle, with rows of server racks on both sides. The image is overlaid with a semi-transparent red filter. The Virtuozzo logo is in the top left corner, with a red 'z' and the word 'Virtuozzo' in white.

Virtuozzo

Thanks for your
attention.
Q&A.

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