Elivepatch
Flexible distributed Linux Kernel live patching

Alice Ferrazzi
Takanori Suzuki

kernel :~ $ whoami

Alice Ferrazzi

- Gentoo
  - Gentoo Kernel Project Leader
  - Gentoo Google Summer of Code administrator and mentor for rust Gentoo project
- Cybertrust Japan
  - OSS Embedded Software Engineer

kernel :~ $ whoami

Takanori Suzuki

- Gentoo
  - Gentoo study meeting co-organizer
- Cybertrust Japan
  - OSS Monitoring Software Developer
  - CI Developer

Summary

- Live patch explanation
- Current live patch services
  - Motivation for elivepatch
- Elivepatch solution
  - Implementation
  - Challenge
  - Status
  - Future Work
- Conclusion

At first this project was part of Google Summer of Code 2017 for the

Gentoo organization.

Live patch explanation

Live patch

Modify the kernel without the need to reboot.

Why

- Downtime is expensive (containers, supercomputers)
- Security (vulnerability time shorter)

Where

- Embedded
- Desktops
- HPC (complex scientific computations)
- Cloud
- Any computer under heavy load

What

Kgraft

Suse Open Source live patching system that is routing the old function gradually.

Kpatch

Red Hat Open Source live patching system and use ftrace and stop_machine() for route functions toward the new function version.

Livepatch

Livepatch is a hybrid of kpatch and kgraft.

Livepatch has been merged into the kernel upstream.

Kpatch-build can work with both kpatch and livepatch for creating the live patch.

Livepatch is just a module

...

Livepatch module problem

A module that takes just about 1+ hour
to compile in a modern server

At Gentoo, we know what means to compile something for more than 1 hour…

Gentoo solution to compile for 1+ hour compilation problem

- Gentoo “binary host”
- Pre-compiled binary

What options do we have for compiling livepatch modules?

Current existing livepatch services

Current vendor solutions

- Oracle, Ksplice (support only Oracle Linux kernels)
- Suse Linux Enterprise Live Patching (support only Suse Kernels for one year)
- Canonical Live Patch (support only Ubuntu 16.04 LTS and Ubuntu 14.04 LTS)
- Red Hat live patch (Support only Red Hat kernel)

Motivation for elivepatch

Problems of vendor solutions

- **trusting on third-party** vendors
- Lacking support for **custom kernel configurations**
- Lacking support for **request-driven** costumization
- Lacking **long term** support
- **Closed source**

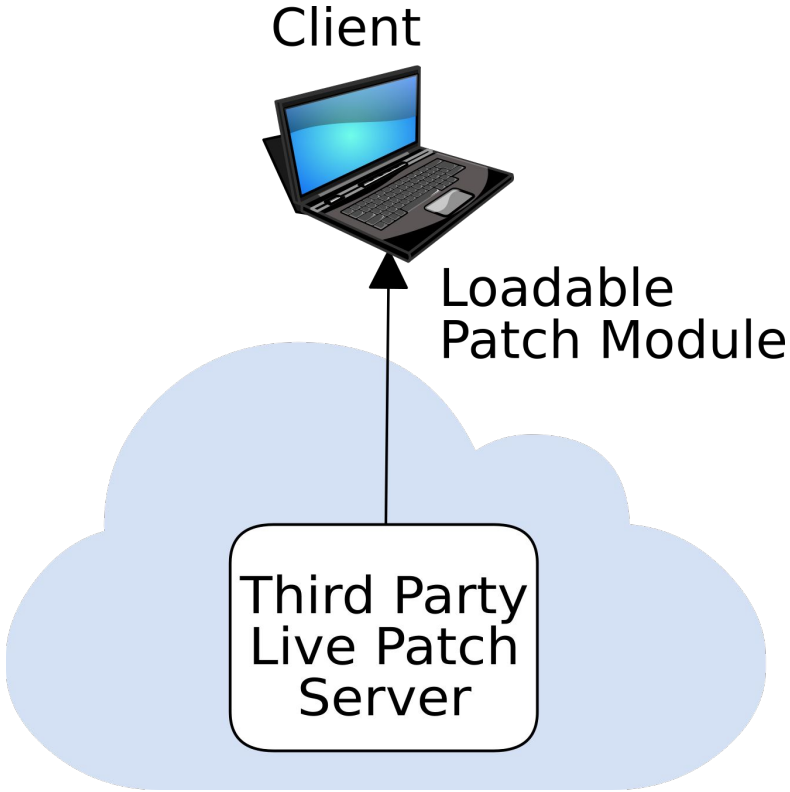
elivepatch solution

elivepatch

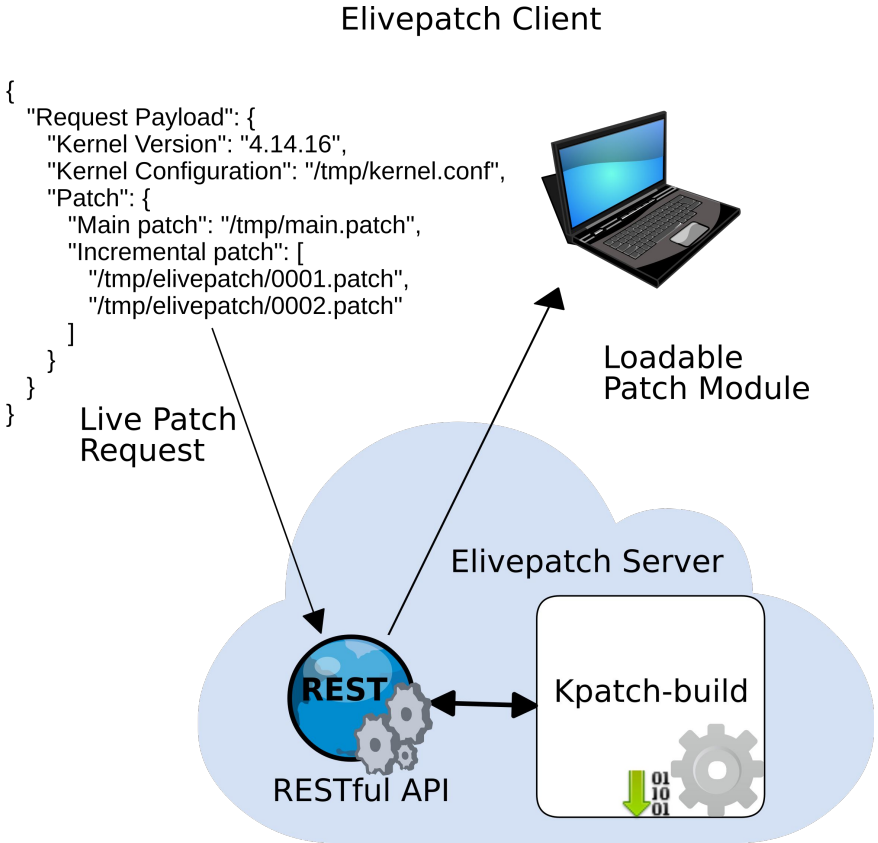
A web service framework to deliver Linux kernel live patches

- Supports **custom kernel configurations**
- User participation via **request-driven** customization
- **Open source**

Vendor solutions representation



Elivepatch solution



Implementation

Elivepatch-server (Main language: Python)

Flask + Flask-Restful + Werkzeug (not dependent)

Elivepatch-client (Main language: Python)

Requests + GitPython

Challenges

Challenges with elivepatch

- Some patches require manual modification to be converted to live patches
- Reproducing the build environment can be difficult:
  - Differences in compiler versions
  - Variations in the compiler and optimization flags
- Incompatible machine architectures (solaris, hpc)

Incompatibility with GCC

CCFLAGS and non vanilla gcc,

can sometime broke elivepatch.

Current status

Elivepatch status

- First open source release 0.1 on 2017/9/06
- Packaged for Gentoo
- Kpatch version 0.6.2 in Gentoo
- Presented as poster at SOSP 2017
- Close collaboration with kpatch mainteiners

Future work

Future work

- Toward livepatch automatization
- Increasing scalability using containers and virtual machines
- Livepatch signing
- Kernel CI\CD check

Toward livepatch automatization

- Priority is to automatize the livepatch creation when there are no semantic changes.

  For example, we need to detect inlined functions and optimizations that require including more functions into the livepatch.
- Need a tool for creating the extra relocations entries.

Linux Plumbers 2018

- Architecture support
  - objtool for ppc (**Miroslav Benes, Kamalesh Babulal, Josh Poimboeuf**)
  - s390x (**Joe Lawrence, Miroslav Benes**)
- Dealing with gcc optimizations intefering with livepatches (**Miroslav Benes**)
- userspace tooling for automating patch generation (**Alice Ferrazzi, Miroslav Benes, Nicolai Stange**)
  - elivepatch presentation / discussion (**Alice Ferrazzi**)
- How to implement a sane notion of global consistency (**Nicolai Stange**)
- compatibility of livepatches between framework versions (**Joe Lawrence, Petr Mladek, Nicolai Stange**)
- general experience sharing after 1+ years of livepatching being [comercially] supported in distributions (**Josh Poimboeuf?, Jiri Kosina, ... ?**)

Multi distribution

Solve distributions compatibility issues

Current target:

- Debian
- Fedora
- Gentoo
- Android

Elivepatch client on Debian

```
root@debian-amd64:~/elivepatch-client# clear
root@debian-amd64:~/elivepatch-client# PYTHONPATH=/root/elivepatch-client python3 bin/elivepatch --kernel 4.9.0 --url http://192.168.122.2:5000 --debug --version --config /boot/config-4.9.0-6-amd64 --patch ~/main
patch --distro debian
Namespace(clear=False, conf_file=None, config='/boot/config-4.9.0-6-amd64', cve=False, debug=True, distro='debian', kernel_version='4.9.0', patch='/root/main.patch', url='http://192.168.122.2:5000', version=True)
List of current patches:
[]
This session uuid: 5cadb73d-cd16-4a08-9648-5398b4b56e3d
debug: kernel version = 4.9.0
incremental_patches: []
[('main_patch', ('main.patch', <_io.BufferedReader name='/root/main.patch'>, 'multipart/form-data', {'Expires': '0'})), ('config', ('config', <_io.BufferedReader name='/tmp/tmpl3_cv_v2'>, 'multipart/form-data', {
Expires': '0'}))]
send file: {'Response': 'debian is not yet supported'}
livepatch not received
root@debian-amd64:~/elivepatch-client#
```

Work in progress…

https://asciinema.org/a/187738

p.s. Gentoo kernel is still needed

Livepatch signing

- Implementing livepatch module signing in the server
- Implementing signing verification for the client

Kernel CI/CD checking

- Implement a buildbot plugin for testing elivepatch
- Implementing elivepatch-server on docker,
  for a ready to use livepatch building instance

[You can test your livepatch with the same settings and hardware as where you want to deploy it]

Conclusion

Epilogue

- Live patch is a module that takes time compiling
- Live patch vendor service solutions solving the compilation problem
- Elivepatch solution

With the diffusion of embedded systems and robotics,

Livepatch services will become always more important

If you are interested in contributing,
Elivepatch is welcoming every form of contribution.

https://github.com/gentoo/elivepatch-client