CE Workgroup

Embedded Linux Community Update

Feb 2022

Tim Bird

Principal Software Engineer, Sony Electronics

Nature of this talk…

- Quick overview of lots of embedded topics
- A springboard for further research
  - If you see something interesting, you have a link or something to search for
- Some overlap with material given previously
  - I may go quickly over some older slides
- Not comprehensive!
  - Just stuff that I saw

Outline

Linux Kernel
Technology Areas
Conferences
Industry News
Resources

Outline

Linux Kernel

Technology Areas

Conferences

Industry News

Resources

Linux Kernel

- Versions
- Stuff In Progress
- Development Stats
- Development Tools and Workflow

Kernel Versions

- Linux v5.12 – 25 Apr 2021 – 70 days
- Linux v5.13 – 27 Jun 2021 – 63 days
- Linux v5.14 – 29 Aug 2021 – 63 days
- Linux v5.15 – 31 Oct 2021 – 63 days
  - “Trick or Treat” release
- Linux v5.16 – 9 Jan 2022 – 70 days
- Linux v5.17-rc2 – current version this week
  - Probably 5.17 will be released on 13 Mar 2022

Linux v5.12 (Apr 2021)

- Support for oprofile removed
  - superceded by perf events
- “PREEMPT_DYNAMIC” allows selecting preemption mode at boot or run time
- Dynamic thermal power management
  - Allow power usage of groups of devices to be capped to meet thermal constraints
- Nintendo 64 support (finally!)
  - Not sure how useful this is when the console only supports 8MB RAM, but hey!

Linux v5.12 (cont.)

- Build system can use Clang's link-time optimization (LTO) features on ARM64 and x86 architectures
- kfence memory debugging tool has been added
- Some new perf-events features:
  - Can report on instruction latency
  - Daemon mode for long-running sessions
  - See https://git.kernel.org/pub/scm/linux/kernel/git/torvalds/linux.git/commit/?id=3a36281a1719
- Support for Playstation DualSense game controllers *(yeah Sony!)*

Linux v5.13 (June 2021)

- Support for Control-Flow Integrity (CFI)
- Software-interrupt processing code from the Preempt RT tree was mainlined
- logbuf_lock used by printk has been removed
  - working towards lockless printk
- Support for Generic USB Display (GUD) driver
- BPF programs can now call (some) kernel functions directly
- /dev/kmem was removed (!!)
- Added new WWAN networking framework
- Landlock security module

(Many of these explained later)

Linux v5.14 (August 2021)

- memfd_secret system call was added
  - Details on next slide
- new tracers
  - osnoise - show application delays cased by kernel activity
  - timerlat – detailed info about timer-based wakeups
- A fair amount of Qualcomm and MediaTek driver code
  - clocks, pin controllers, sound
- “simpledrm” driver
  - direct-rendering interface for simple framebuffer devices
- Kunit can run tests under QEMU (in addition to native and UML)

memfd_secret system call

- Creates a region of memory that even the kernel cannot directly access
  - Pages are removed from the kernel's direct map
  - Intended to be used for cryptographic info (e.g. keys)
- Makes it difficult for other processes or even the kernel to unintentionally (or even intentionally) access the memory
  - See https://lwn.net/Articles/835342/
  - For many more details, see https://git.kernel.org/pub/scm/linux/kernel/git/torvalds/linux.git/commit/?id=1507f51255c9

Linux v5.15 (October 2021)

- Realtime preemption locking code – “Sleeping spinlocks”
  - It’s a big deal - More on this later
- More io_uring performance enhancements
  - “BIO recycling”
- Core scheduler support for asymmetric systems
  - Cores on the same chip that can run either 64-bit or 32-bit
    - How to deail with scheduling when the processor can’t even execute some code
  - See https://lwn.net/Articles/838339/
- ksmbd – in-kernel SMB server (!!)
  - Not a replacement for Samba, but provides better optimization for Linux in some situations

Linux v5.15 (cont.)

- printk indexing
  - Can extract all printk messages from kernel
    - Is used to detect changes that could break log-parsing tools
- DAMON system merged (Data Access Monitor)
  - See next page
- kernel new uses –Werror flag during build, by default
  - A compiler warning will cause the build to fail
- If LLVM=1 (env var), you don’t need to specify CROSS_COMPILE
- Minimum gcc version is now 5.1

DAMON system

- DAMON = Data Access Monitoring tool
- Provides tools to record data access and show visualizations of access patterns
- Different visualizations available
  - A heatmap of memory access for your workload
  - Graphs showing information about working set size
- See https://damonitor.github.io/doc/html/v17/admin-guide/mm/damon/index.html
- *Nice diagnostic tool... but is it actually more?*

Linux v5.16 (January 2022)

- EROFS (Enhanced Read-Only FS) continues to get new features
  - Multiple-device support
- io_uring operations can now have security policies enforced by SELinux or Smack
- First set of patches for folios
  - New memory data type (described later)
- DAMON operation schemes added
  - DAMON can perform pro-active page reclaim, and monitor the physical address space
  - See https://lwn.net/Articles/863753/

Linux v5.17 (expected in March)

- Random number generator replaced SHA1 with BLAKE2 hash function
  - Results in 370% increase in RNG performance
- RTLA – realtime analysis tools have been added
  - osnoise and timerlat (not sure how these are different from the tracers added in 5.4)
- Some changes to flags fields used in FUSE_INIT call
  - Check your FUSE filesystems and tools for compatibility

Stuff In Progress

- A few things being worked on
  - Page folios
  - Multi-generational LRU
  - Rust for the kernel
  - Zero-copy network transmissions with io_uring
- See https://lwn.net/Articles/881675/

Folios

- Folio = New data type to indicate a pointer to a page that is NOT the tail of a compound page
  - Basically, it's an internal typing improvement to memory management
- To avoid issues with passing a pointer to a page (part of a compound page) with wrong attributes
  - Sometimes, a routine doesn't work properly with a tail page
- Some kernel devs like them, and some don't
- See https://lwn.net/Articles/849538/
- Some parts of folio code adopted in 5.16 and 5.17
  - Still not actually used yet

Multi-generational LRU (MGLRU)

- Currently have 2 queues for managing page eviction
  - Active and inactive
- MGLRU propose multiple queues and a more complex algorithm
  - Less CPU overhead
  - Better working set estimation
  - Proactive reclaim (which lowers memory pressure)
- Big debate about whether it could be merged in 5.17
  - It wasn't merged, but it has supporters
    - Google says they're already using it and it's working well
    - See https://www.phoronix.com/scan.php?page=news_item&px=Multigen-LRU-v5

Rust for the Linux kernel

- People want to support Rust code in the Linux kernel
- Third version of the Rust support patch was posted in January
- Is a difficult problem because Rust programs don't normally have to deal with memory allocation failures
  - Requires a modified memory allocator that can handle failures
- Lots of features are still unstable
- Has not been accepted into kernel yet, but work is proceeding

Zero-copy networking with io_uring

- RFC patch by Pavel Begunkov
  - Not sure when it would be ready for upstreaming
- About 1.5 to 2 times faster than current (socket-based) zero-copy networking
- See https://lwn.net/Articles/879724/

Linux 5.16 developer stats

- Most active 5.16 developers
- By changesets:

Person	Changesets	Percent
Michael Straube	286	2.0%
Cai Huoquing	232	1.6%
Jakub Kicinski	200	1.4%
Christoph Hellwig	158	1.1%
Bart Van Assche	157	1.1%

- Michael Struabe worked on the r8188eu wireless network driver

Table data:
https://lwn.net/Articles/880699/

Linux 5.16 developer stats

- Most active 5.16 developers
- By lines of code:

Person	Lines changed	Percent
Ping-Ke Shih	91116	11.4%
Zhan Liu	34501	4.3%
Nick Terrell	28611	3.6%
Sameer Pujar	15121	1.9%
Johan Almbladh	13901	1.7%

- Ping-Ke Shih submitted the Realtek rtw89 driver (which skipped the staging tree)

Table data:
https://lwn.net/Articles/880669/

Most active employers for 5.16

- Most active active employeers for the 5.16 kernel:

Company	Changsets	Percent
Intel	1454	10.2%
(Unknown)	1196	8.4%
Google	932	6.6%
(None)	781	5.5%
Red Hat	765	5.4%

- “Unknown” consisted of about 400 developers, most with one or two patches
  - Some are “drive by” contributors, and some will stay around

Table data:
https://lwn.net/Articles/880599/

Kernel commit log entries

- Number of commit log entries, per kernel version

Company	git log count	developer count
5.12	14167	1938
5.13	17187	2131
5.14	15871	1982
5.15	13473	1856
5.16	15384	2074
5.17-rc2*	12264*	1715*

- Extracted using ‘git log v5.yy..v5.zz –oneline | wc –l’ and ‘author-stats v5.yy..v5.zz | wc –l’

Table data: https://lwn.net/Articles/880599/

Kernel Development

- Lore + Lei
- Using github for kernel work

Lore + Lei

- Lore archive has become indispensable for kernel devs
  - https://lore.kernel.org/ and https://lore.kernel.org/all
  - Searches are very fast, even over all repositories
  - Can do smart searches (AND, OR, NOT, regexes, and context qualifiers)
    - s: = match within Subject
    - nq: = in non-quoted portion of text
    - dfn: = match filename from diff
    - dfhh: = match diff hunk header (usually a function name)
  - See https://lore.kernel.org/all/_/text/help/
- LEI = local email interface
  - Tool to search lore, and create a local mail box with results

Lei workflow

- Lei is great for kernel developers
  - It allows them to avoid subscribing to email lists
    - While still catching items of interest (no matter which list it appears on)
- Developer can create a query for items of interest
  - Lei remembers query, so user can issue it again
  - Example query on next page
- Can process local mailbox offline, using familiar mail tools
  - e.g. Can use ‘mutt’ instead of web interface or GUI
- See https://lwn.net/Articles/878205/

Sample lei search

- Here's a query that a floppy driver maintainer might use:
  - lei q -I https://lore.kernel.org/all/ -o ~/Mail/floppy \
    --threads --dedupe=mid \
    '(dfn:drivers/block/floppy.c OR dfhh:floppy_* OR s:floppy \
    OR ((nq:bug OR nq:regression) AND nq:floppy)) \
    AND rt:1.month.ago..'
- Which means to store emails that:
  - have a patch that touches floppy.c (dfn:drivers/block/floppy.c)
  - have a patch that changes a function whose name starts with floppy_ (dfhh:floppy_*)
  - have "floppy" in the subject (s:floppy)
  - mention both "floppy" and either "bug" or "regression" in non-quoted text ((nq:bug OR nq:regression) AND nq:floppy)
  - were received in the last month (rt:1.month.ago)

Using github for kernel work

- Konstantin Ryabitsev is working on a bot that can turn a github pull request into an email patch series
- Idea is to allow a developer using Github* to submit a patch
  - *(or Gitlab or some other git “forge”)
  - Works around difficulty of setting up an e-mail-based workflow
  - It handles things like running checkpatch.pl and get_maintainers
- Some maintainers are wary about allowing this workflow
  - In their view, Github doesn’t promote some desirable practices
    - e.g. There’s no way to review a commit message on github, so commit messages tend to be poor
- See https://lwn.net/Articles/860607/

Outline

Linux Kernel

Technology Areas

Conferences

Industry News

Resources

Technology Areas

- Audio
- Core Kernel
- Filesystems
- Graphics
- Languages
- Networking
- Security
- Testing
- Toolchains

Audio

- PipeWire continues to gain ground
  - Intended to replace PulseAudio and JACK
  - Is higher performance
  - WirePlumber is a new session manager for PipeWire
    - Scriptable in LUA
  - See Talk by Geoge Kiagiadakis (Collabora) from ELC 2021
    - https://elinux.org/images/f/fb/Master_your_pipewire_streams_with_wireplumber.pdf

Core Kernel

- memfd_secret (v5.14)
- printk_indexing (v5.15)
- scheduling for asymmetric processors (v5.15)
- RNG speedups (using BLAKE2 hash) (v5.17)

Filesystems

- io_uring continues to mature
  - As a reminder: see https://lwn.net/Articles/810414/
  - Performance enhancements (v5.15)
  - Can be security-regulated by SELinux or Smack (v5.16)
  - Support for zero-copy networking (coming)
- EROFS and F2FS continue to mature
  - Better compression support
  - Better xattr support
- FUSE_INIT flag changes (v5.17)

Graphics

- Generic USB Display driver mainlined in v5.13
  - Allows to push graphics and video over USB
  - Can be used to turn a raspberry PI zero into a USB-to-HDMI adapter
    - See https://github.com/notro/gud/wiki
  - See https://www.phoronix.com/scan.php?page=news_item&px=Generic-USB-Display-GUD-5.13
- “simpledrm” driver merged in 5.14
- legacy fbdev sub-system gets a maintainer (Jan, 2022)
  - But some people didn’t like it (see next page)

Reviving fbdev

- New maintainer was found for fbdev code: Helge Deller
  - Maintainer change was a bit too quick for some people
    - But the status had been listed as “Orphan” in MAINTAINERS
- Controversy was over restoration of hardware acceleration for scrolling
  - Revert of a patch removing hardware acceleration for 2D scrolling for legacy fbdev devices
- Quite frankly, it looks like the DRM devs having a turf war over something they weren’t maintaining
- IMHO should let the new maintainer try and see what happens
- See https://lwn.net/Articles/881827/

Languages

- Rust
- Python

Rust

- Rust being applied to security-sensitive tools
  - Rust version of GNU coreutils
    - Work is progressing
    - See https://www.phoronix.com/scan.php?page=news_item&px=Rust-Coreutils-Jan-2022
    - MIT license (!)
- Rust in the kernel

Rust in the Linux kernel

- People are working to support the Rust language for kernel driver development
  - Have been talking about it for a while
  - Posted RFC to kernel mailing list in April
- Big advantage (claimed) is memory safety features of Rust built in to the language
- Reaction of kernel developers is mixed:
  - Don't want to require kernel developers to know more languages
  - Not sure benefit is worth the cost
  - Most maintainers seem to have a "wait and see" attitude
- 3rd version of system posted in January

Python

- Some distros have disabled python2 by default (SUSE)
- Cpython is getting faster
  - https://lwn.net/Articles/857754/
- Python 3.10.0 released Oct. 4, 2021
  - Better error messages
  - Better debugging
  - Structural pattern matching (case statements with matches)
- Having issues with removal of deprecated functions
  - Breaks backwards compatibility
  - Developers can’t seem to leave the language alone
  - See https://lwn.net/Articles/883391/

Networking

- Wireless WAN (WWAN) framework added to kernel (v5.13)
  - Also known as “Mobile Broadband”
  - Usually provided by cellular networks such as 2G, 3G, 4G LTE or 5G and cellular modems
  - First user is a Qualcomm wwan modem driver
  - Adds the concept of a WWAN port, which is a logical pipe to a modem control protocol
  - See code in drivers/net/wwan
    - Unfortunately, there doesn’t seem to be any docs under Documentation
  - See https://www.phoronix.com/scan.php?page=news_item&px=Linux-WWAN-Subsystem-v9

Networking (cont.)

- Always a stream of oddball networking features and enhancements:
  - Custom configuration of hash policies for multipath IP traffic
  - Support for per-VLAN multicast
  - Support for Management Component Transport Protocol (MCTP)
  - Unix-domain sockets now support out-of-band data
  - SO_RESERVE_MEM can reserve kernel memory and speed up some operations
  - Support for Automatic Multicast Tunneling (ATM)
  - New sysctl knobs for tuning the ARP cache behavior
  - And so on...

Real-Time

- PREEMPT_DYNAMIC allows selecting preemption mode at boot time or run time (v5.12)
  - Can be “none”, “voluntary”, or “full”
  - There’s an option under debugfs for controlling the mode at run time
- rtla – real-time Linux analysis tool (5.17)
  - See https://www.phoronix.com/scan.php?page=news_item&px=Linux-5.17-RTLA
- PREEMPT_RT status
  - Software-interrupt processing code mainlined (v5.13)
  - Sleeping locks was mainlined (v5.16)

RT preemption locking code

- Provides “sleeping spinlocks” (and sleeping rwlocks)
  - Allows for process switch (schedule) while a lock is held, which is the core feature of PREEMPT_RT
- Must turn on CONFIG_PREEMPT_RT config option
  - Extensively tested to verify that non-RT kernels are not affected
  - See also CONFIG_RT_MUTEXES
- See the commit for details: https://git.kernel.org/pub/scm/linux/kernel/git/torvalds/linux.git/commit/?id=e5e726f7bb9f
- Merged in kernel v5.15
  - After 17 years of development effort and many reworks and refactorings

What's left

- What's left in PREEMPT_RT patches out of mainline:
  - About 3,000 lines of code, affecting 133 files (in 101 patches) (!!)
    - Some big changes to printk
    - Some changes to the random number generator, 8250 serial driver, the core scheduler, cgroups, tracing, memcontrol, i915 DRM driver
  - People are anxious for Linux RT without having to apply a patch
- See https://mirrors.edge.kernel.org/pub/linux/kernel/projects/rt/5.17/patches-5.17-rc2-rt3.tar.gz

Security

- Kernel hardening
- Control-flow integrity
- Landlock security module

Kernel hardening

- Control-Flow Integrity (v5.13)
- strict memcpy() bounds checking (v5.16)
  - https://lwn.net/Articles/864521/
- Spectre mitigations
  - There always seem to be new speculative execution vulnerability mitigations
  - Interestingly, v5.16 removed some Spectre-mitigation behvior for seccomp()
    - Devs decided that the extra mitigations weren't really buying more security

Control-Flow Integrity (CFI)

- Mainlined in v5.13 kernel
- CFI checks that indirect call goes to function with same signature as expected
  - At the start of the function
- Detects if malicious code has changed the destination site for an indirect call
  - There are literally thousands of indirect calls in the kernel
- Feature merged in v5.13 is referred to as “forward-edge CFI”
  - There are separate mechanisms for guarding returns (“backward-edge CFI”

Control-Flow Integrity (cont.)

- Requires Clang and Link Time Optimization
  - All indirect call targets are analyzed at compile time and put into jump tables
    - Loadable modules are handled separately
- Check is made at execution time that indirect call is to a valid target
  - Incurs less than 1% overhead (claimed)
- ARM64 supported now
  - x86 support is in the works
- See https://lwn.net/Articles/856514/ and https://lwn.net/Articles/810077/

Other security bits

- Landlock Security Module (v5.13)
- polkit vulnerability fix
  - in-progress patch to prevent argc == 0 problem

Landlock security module

- Landlock security module (new in v5.13)
  - Allows a process to be converted to a secure mode where the kernel can do additional validation of file system operations
  - Allows attaching a ruleset to a process, that allows the system to manage access control to files
  - Allows regular users to create secure execution environments
    - Not just sysadmins and root
  - Accepting a new security module is a big deal
    - There are not many Linux security modules in the kernel
    - This one took over 5 years and 74 revisions to get accepted
  - See https://lwn.net/Articles/703876/

Landlock sample

- See demonstration program in kernel source tree at samples/landlock/sandboxer.c
  - Set LANDLOCK_ALLOWED environment variable to a list of directories
  - Sart a program with the ‘sandboxer’ app
  - Program can only access files under the specified directories

Testing

- Systems
- Suites of tests
- Board farms and test hardware

Test Systems

- Systems:
  - KernelCI – has added kselftest git repo to list of trees it tests
  - Syzbot – always producing more fuzzing failure cases
  - CKI – providing many reports to upstream
  - Fuego
  - CompassCI
  - LKFT – providing many reports to upstream

Test Suites

- LTP
  - Latest release: 20220121 (Jan 21, 2022)
    - New tests for quotactl, statx, epoll, creat, dup, and fixes for others
    - Features (e.g. metadata parser) to make the test executor smarter
    - See https://github.com/linux-test-project/ltp/releases
- kselftest
  - New tests for ALSA, arm64, BPF, DAMON, network drivers, ftrace, gpio, kvm, network forwarding, netfilter, powerpc, RCU and others
- Kunit
  - Documentation cleanup, output format cleanup
  - Ability to run under QEMU

Board Farm APIs

- Standardized Board Farm and hardware testing APIs proposed by TimeSys and Sony
  - Proposed APIs for Power Measurement, Camera and video, and Serial port testing
  - See ELC 2021 presentation: https://elinux.org/images/d/da/ELC-2021-Board-Farm-Update-Bansal-Bird.pdf
- Multi-function DUT control board by Pengutronix
  - See ELC 2021 presentation: https://elinux.org/images/4/43/Cfi_Automated-Testing.pdf

Toolchains

- GCC
  - Kernel now requires gcc 5.1 to build
  - GCC 11.2 released July 28, 2021
    - See https://gcc.gnu.org/gcc-11/changes.html
- LLVM
  - For kernel builds, use of LLVM does not require CROSS_COMPILE environment variable (or make variable)
  - LLVM 13.0.0 released October 4, 2021
    - https://releases.llvm.org/13.0.0/docs/ReleaseNotes.html

Outline

Linux Kernel
Technology Areas
Conferences
Industry News
Resources

Conferences – 2021

- ELC 2021
- Open Source Summit Japan, 2021

Embedded Linux Conference 2021

- Hybrid (Seattle and virtual), September 2021
  - Was “ELC Europe”, but had to combine into a single event in 2021
- Was challenging:
  - Many people could not attend ELC in-person
  - Only a few talks on-site
- Still good content:
  - https://elinux.org/ELC_2021_Presentations
  - Slides and videos are available (with a few exceptions), linked from that page

Open Source Summit Japan, 2021

- Changed to December, and went virtual
- Schedule (with slides) at: https://ossalsjp21.sched.com/
- Video playlist: https://www.youtube.com/playlist?list=PLbzoR-pLrL6rfdmASBlf5hioXQF26gJhQ

Conferences - 2022

- Embedded Linux Conference North America
  - June 22-24, Austin, Texas, USA
  - Hybrid event – in-person and virtual
  - CFP is open now (closes March 14)
- Embedded Linux Conference Europe
  - Sept 13-16, Dublin, Ireland
  - Hybrid event – in-person and virtual
  - First in-person event in Europe after COVID-19 pandemic

COVID-19 issues?

- ELC 2021 was first in-person event by Linux Foundation
  - (well, Open Source Summit 2021, in Seattle)
- Things looked like they would open up (June 2021), but then didn't
  - Delta and Omicron variants caused resurgences
  - Continuing pandemic posed problems for ELC 2021
- Events will continue with hybrid style for many months
- We are still learning how to handle hybrid events
  - How to give all attendees (both in-person and virtual) as good an experience as possible?
  - How to help in-person and virtual attendees mingle, for that "hallway networking" effect that is so valuable?

Open Source Summit

- Becoming an “umbrella” event
  - In Austin, there are 13 sub-events, including ELC
    - LinuxCon, ELC,Embedded IOT Summit, CloudOpen, ContainerCon
    - OSPOCon, Community Leadership Conference
    - Supplychain SecurityCon, Critical Software Summit
    - Open AI + Data Forum
    - Diversity Empowerment Summit, Open Source On-Ramp
    - Emerging OS Forum
      - Metaverse, WebAssembly, Public health, Climate, Crypto/Blockchain

Outline

Linux Kernel
Technology Areas
Conferences
Industry News
Resources

Industry News

- Trade associations
  - Linux Foundation
- Security news
- Interesting cases of embedded Linux

Linux Foundation

- Training and mentorship has really ramped up:
  - 2M trainings and exams delivered as of Jan 2022
- LFX tools for managing projects
  - Project insights, security, mentorship, crowdfunding, events, training, control center
  - See https://lfx.dev/
- 2021 Annual Report at:
  - https://linuxfoundation.org/wp-content/uploads/2021_LF_Annual_Report_010222.pdf

Linux Foundation stats (as of 2022)

(from LFX dashboard)

739,010 Contributing Developers	11,169 Contributing Companies	30.6M Lines of Code Added Weekly	14.6M Lines of Code Deleted Weekly
2.1M Project Builds	963,390 Logged Issues	13,055 Repositories	263,499 Vulnerabilities Detected
13,802 Vulnerabilities Fixed	200,000 Free Course Enrollments	67,661 Event Attendees in Last 12 Months	2.7M Email Messages Sent
2.1M Chat Messages Sent	35,158 CLAs Signed	10,511 Mentees Applied	26,998 2020 Community Meetings

LF Projects

- Initiatives with recent interesting activities:
  - Linux Foundation Research
  - Open Source Security Foundation
  - Internet Security Research Group
- Projects relevant to embedded
  - Yocto Project, Zephyr, Linux kernel, KernelCI, Automotive Grade Linux, Automated Compliance Toolkit

Linux Foundation Research

- New initiative to measure, analyze and describe the impact of open source collaborations
- Will use data from LF projects and tools (e.g. LFX), as well as other sources, to prepare reports
- Recent reports:
  - The state of SBOM and Cybersecurity Readiness
  - Hyperledger Brand Study
  - Diversity, Equity, and Inclusion in Open Source
  - Data and Storage Trends
  - The State of Open Source in Financial Services Report

Open Source Security Foundation

- Initiatives:
  - Security Scorecard
  - Security Reviews
  - Security Metrics Dashboard
  - Package Feeds / Package Analysis
  - CII Best Practices Badge Program
- Standards:
  - Open Source Vulnerability Schema
  - Supply-Chain Levels for Software Artifacts
- Guides and Training:
  - OSS Vulnerability Guide
  - Free Security Software Development courses: see https://openssf.org/training/courses/

Internet Security Research Group

- Operates “Let’s encrypt”
  - The worlds largest certificate authority
  - To encourage https over http
- Prossimo
  - Improving memory safety for security-sensitive software infrastructure
    - Utilizing memory-safe languages
- Prio
  - Privacy-preserving metrics service
    - Used by Apple and Goolge for Covid-19 Exposure Notification app

Industry Security news

- polkit security vulnerability
- log4j
- Software Bill of Materials (SBOMs)

polkit security vulnerability

- vulnerability due to polkit being setuid, and not handling case where argc == 0
  - polkit assumes there is always argv[0], and started processing at argv[1]
    - Allowed attackers to inject items from environment as if they were part of command line (and change them on the fly)
  - POSIX is ambiguous about where argc == 0 is allowed
  - Easy to fix: chmod 755 /usr/bin/pkexec (remove setuid bit)
  - Kernel may support a fix also
- It's an old bug, that almost got fixed 12 years ago
- See https://lwn.net/Articles/882799

log4j

- Is a java logging library used by over 30,000 projects
- Vulnerability was due to calling an external service as part of interpolating the logging string
  - The loggin string included elements provided by the user
- Fix to log4j itself was actually pretty fast and easy
- However, the way log4j was embedded in projects made it difficult for server administrators to detect if they were affected, and fix it
- Need better methods to track component dependencies
  - And also, better security audits and practices for widely-use modules

Software Bill of Materials

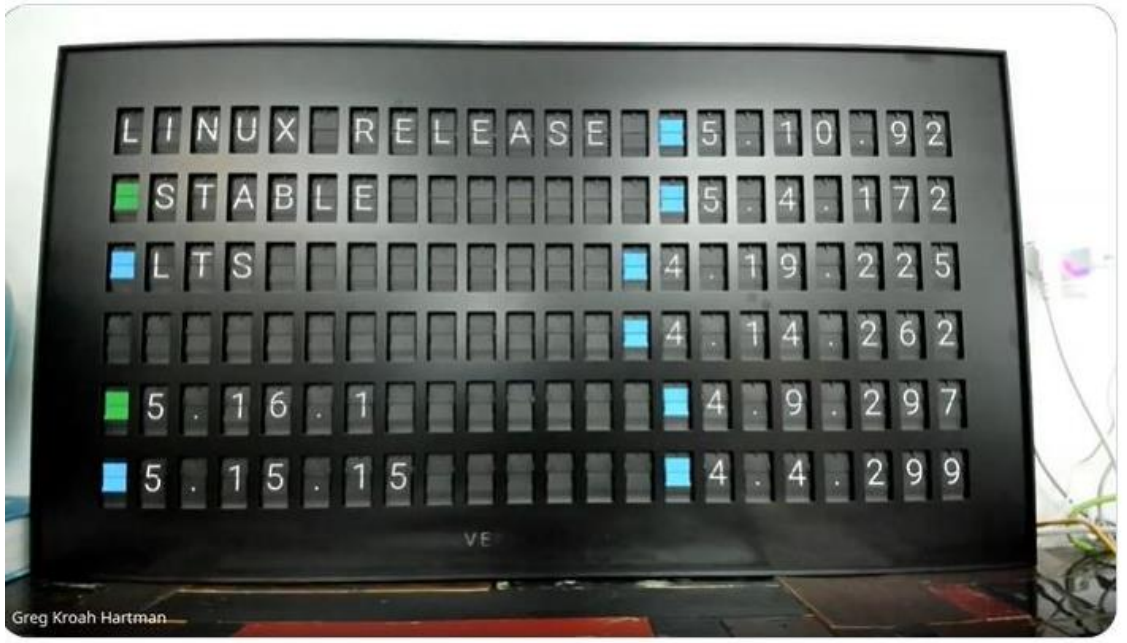
- Is the new buzzword for supply chain security
- SBOMs = way to track and validate source of software as it moves through supply chain
  - Intended to detect and prevent a “Solar Winds” style attack
- LF research did a survey on SBOM and Cybersecurity readiness
  - See https://www.linuxfoundation.org/tools/the-state-of-software-bill-of-materials-sbom-and-cybersecurity-readiness
- See Automating Compliance Tooling (ACT) https://github.com/act-project/TAC
  - Umbrella project including: Fossology, OSS Review Toolkit, SPDX Tools and Tern (SBOMS for containers)

White House summit on Open Source security

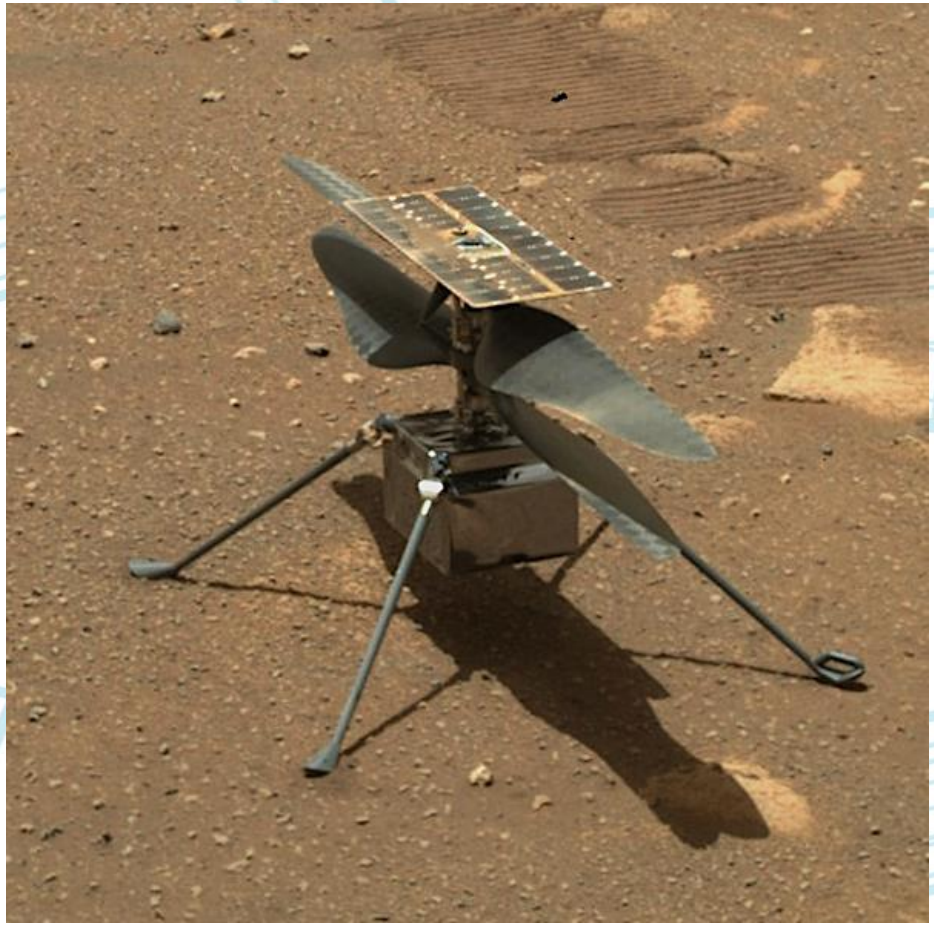
- Linux Foundation was invited to attend Open Source security summit at White House in the US
  - Discussed security issue with OSS in the supply chain
  - Presented status of Open Source Security Foundation projects
    - Best Practices
    - Identifying Critical Projects
    - Metrics and Scorecards
  - Described Project Sigstore
- Many important companies and groups in attendance
  - Google issued a statement of support for public (government) investment in OSS security

Interesting embedded Linux uses

- Starlink satellite count
  - 1552 as of Jan 10, 2022
    - That's over 74000 Linux nodes in low earth orbit
    - Skynet - it's under construction
- GregKH's LTS status signboard
  - See https://twitter.com/gregkh/status/1483330885655183360
- Mars helicopter

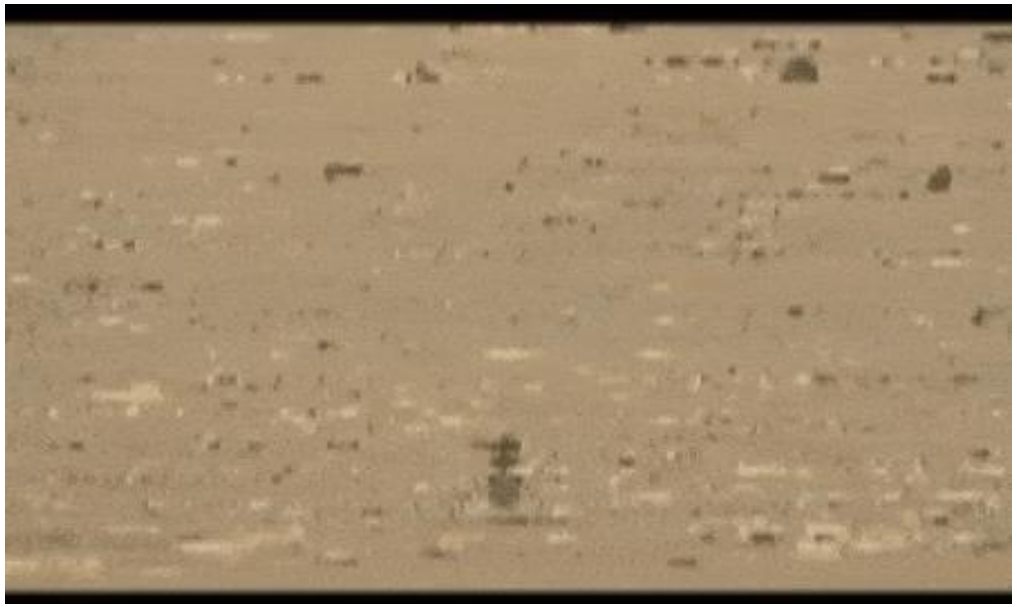


Mars Helicopter - Ingenuity



Mars Helicopter

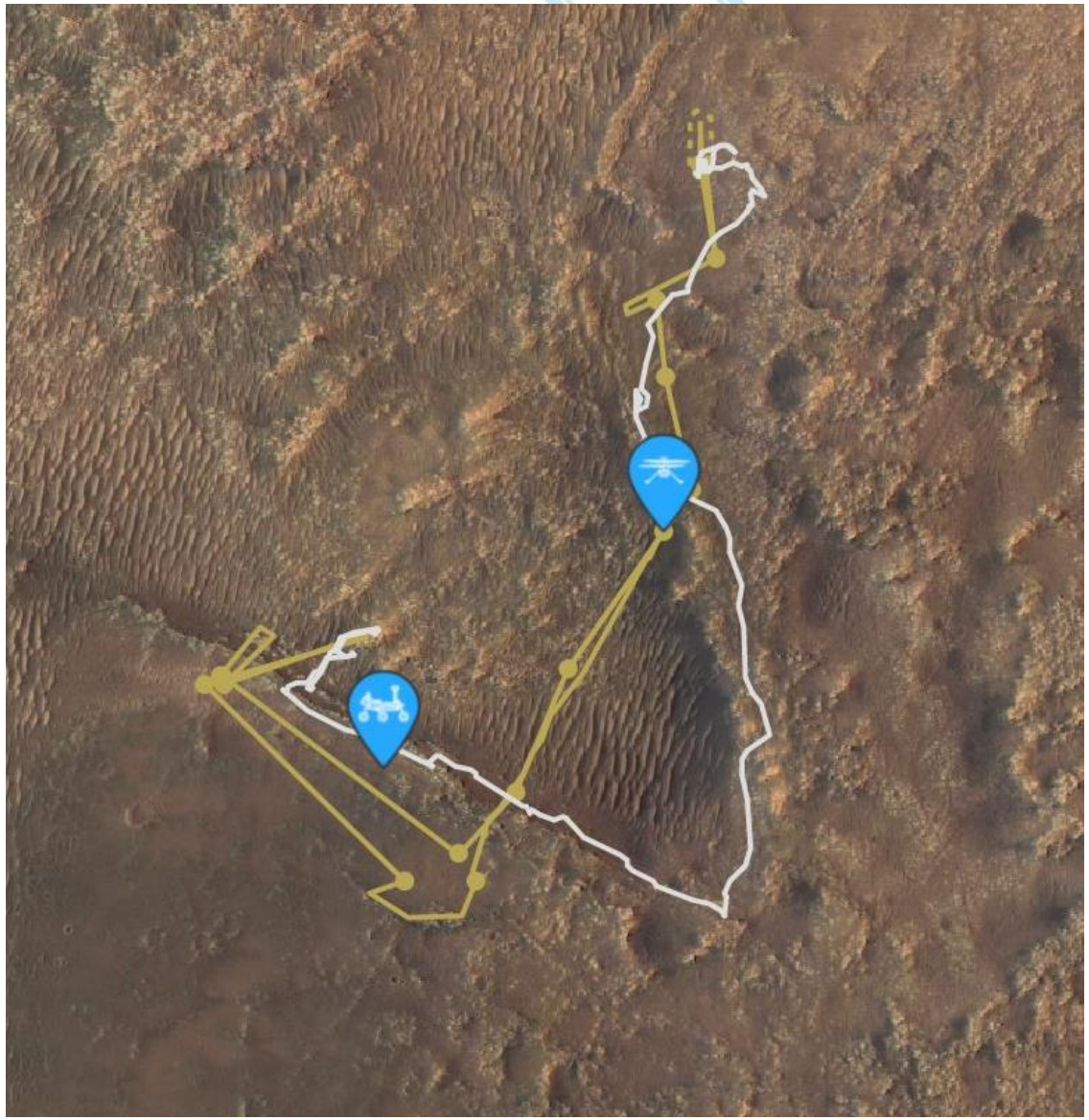
- Mars Ingenuity Helicopter landed in February, 2021 on Mars
- Performed tests and demonstrations in April & May
  - First 5 flights were part of “Technology Demonstration”
- Didn’t formulate a plan for continued flights until later
- Is still flying...
  - Has performed 18 flights so far



Mars Helicopter Software Bugs

- Flight 4 (first attempt) - Failure to transition to flight mode
  - Helicopter did “spin up”, but failed to fly
  - NASA said this was from a “watchdog timer” expiration
    - Unexpected delay transitioning between operating modes
- Flight 6 – Navigation image timestamp issue
  - Helicopter flight was very wobbly and unstable
    - Helicopter rocked back and forth during flight
  - A frame was dropped during flight 6, causing timestamps to be off for subsequent frames
    - Caused problems for navigation and flight stability
- Issues have received software updates (on Mars!)

Ingenuity flights on Mars



Helicopter operation on Mars

- Continuing mission for Ingenuity (“Operations demonstration”)
- ~~Will continue that mission until August, 2021~~
  - Helicopter survived Martian change of seasons
  - Can fly in “summer” atmospheric conditions
    - Uses higher speed for propellers, due to thinner air
- Will continue doing stuff indefinitely
  - Is acting as a scout for items of interest for Rover
- January 2022 status
  - Flight 19 delayed due to dust storm
  - First time a flight was delayed due to bad weather on another planet

Sources for Mars helicopter

- Talk by Tim Canham at ELC 2021
  - Slides:https://elinux.org/images/5/5a/1._TIMOTHY_CANHAM.pdf
  - Video: https://youtu.be/0_GfMcBmbCg

- https://mars.nasa.gov/technology/helicopter/
- https://en.wikipedia.org/wiki/Ingenuity_(helicopter)
- https://thenewstack.io/how-the-first-helicopter-on-mars-uses-off-the-shelf-hardware-and-linux/
- https://www.pcmag.com/news/4-android-smartphones-with-as-much-power-as-nasas-mars-helicopter

Outline

Linux Kernel
Technology Areas
Conferences
Industry News
Resources

Resources

- LWN.net – https://lwn.net
  - If you are not subscribed, please do so
  - Some content is delayed by 2 weeks for non-subscribers (some links in this presentation)
- Phoronix - https://www.phoronix.com/
- eLinux wiki – elinux.org
  - Especially: https://elinux.org/ELC_2021_Presentations
- Google

Thanks!