Next Steps for Reproducible Testing and Deployment

"The attempt to rewrite the foundations of mathematics in terms of category theory is evil and wrong." –Walt Pohl[1]

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MIT Arcturus Autonomy

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[1] Attribution: (Pohl 2005)

Outline

1.1 Nix as the Purely Functional, Monadic Build Tool

- Software directly controls hardware

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**We want a way to tell computers how to run software,
and we want software to run the same way on any system, regardless of its internal state.**

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  - Software has dependencies (for compilation, development, and in production), configurations, targets (supported systems), feasibility relations, and a bunch of other stuff we don't know about ("the world")
- Dealing with dependencies is a very serious problem (packages will require conflicting versions of the same package)

Eelco Dolstra, original Nix theorist

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  - It has a build function that looks like $g : Y \to FZ$

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- We want a **monadic** build system ("The Postmodern Build System" 2023)
- We want **optimized incremental** builds (i.e. the bind operation should be fast and builds should be **pure**)
  - Same input, same output

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  - Distributed builds
    - all systems produce the same binaries

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- Nix is the unique existing build system satisfying both a **reproducibility criterion** and having **high interpretability**

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Figure 1: This is absolutely not true

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- Stuff just works.™

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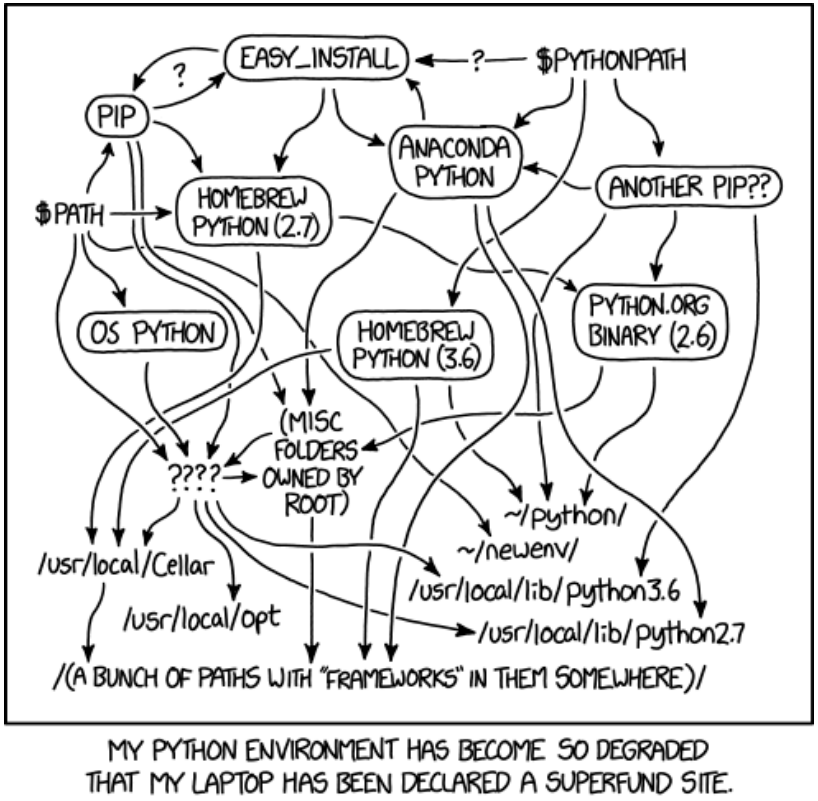

Figure 2: Other so-called "package managers"

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  - About 10x faster compared to the ROS development environment (Purvis and Wanders 2022)

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- Docker is **stateful**, Nix is **stateless**

1.2.10 Docker

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We don't know **why or how stuff works**, only that it works on a given system. Equivalently, any change to the system state (Docker configuration) could lead to critical build failures.

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We can ask questions like *which packages does this module depend on?* or *why did this new build fail?*

1.3 Nix as as the Universal Build Tool

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Nix is often described as a bad implementation of a good theory, mainly because it has actually been implemented and no longer exists in the minds of category theorists

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- Nix is extensible enough to describe build recipes for a wide variety of projects, and ROS is no exception
- However, ROS uses infamously bad dependency specifications and runtime environments

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Due to the severe shock that would result from hacking on Nix code in the primary codebase (as is best practice), the Nix build system has been developed completely independently.

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- **Non-invasive** (using Nix does not interfere with existing working build environments)
- **Isolated** (self-contained, use it only when you want)
- **Verifiable** (benefit from safe binary caching and reprroduce tests on other systems)

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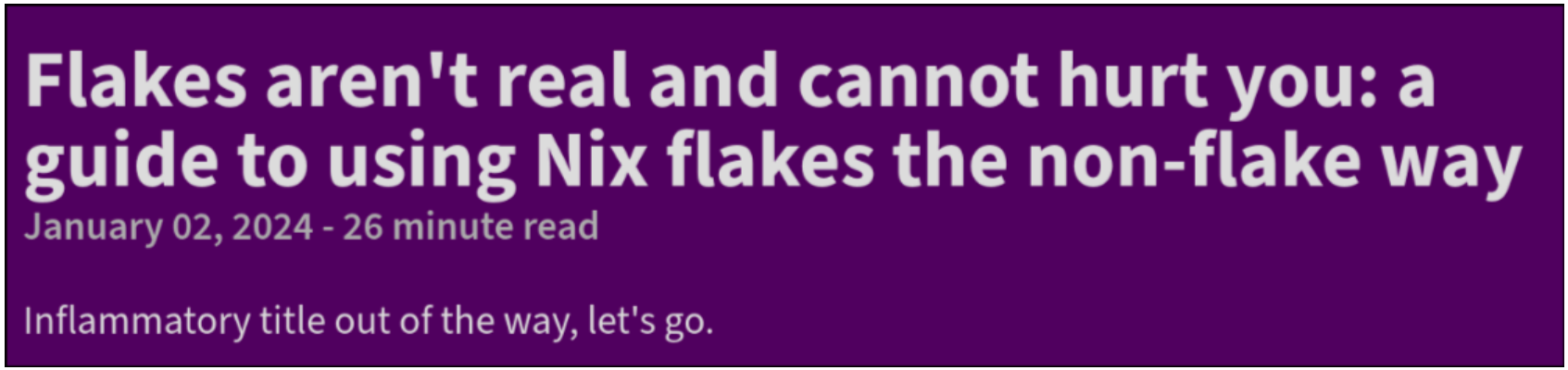

Figure 1: tl;dr: you should be using Nix already

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- Preliminary implementation of a binary cache

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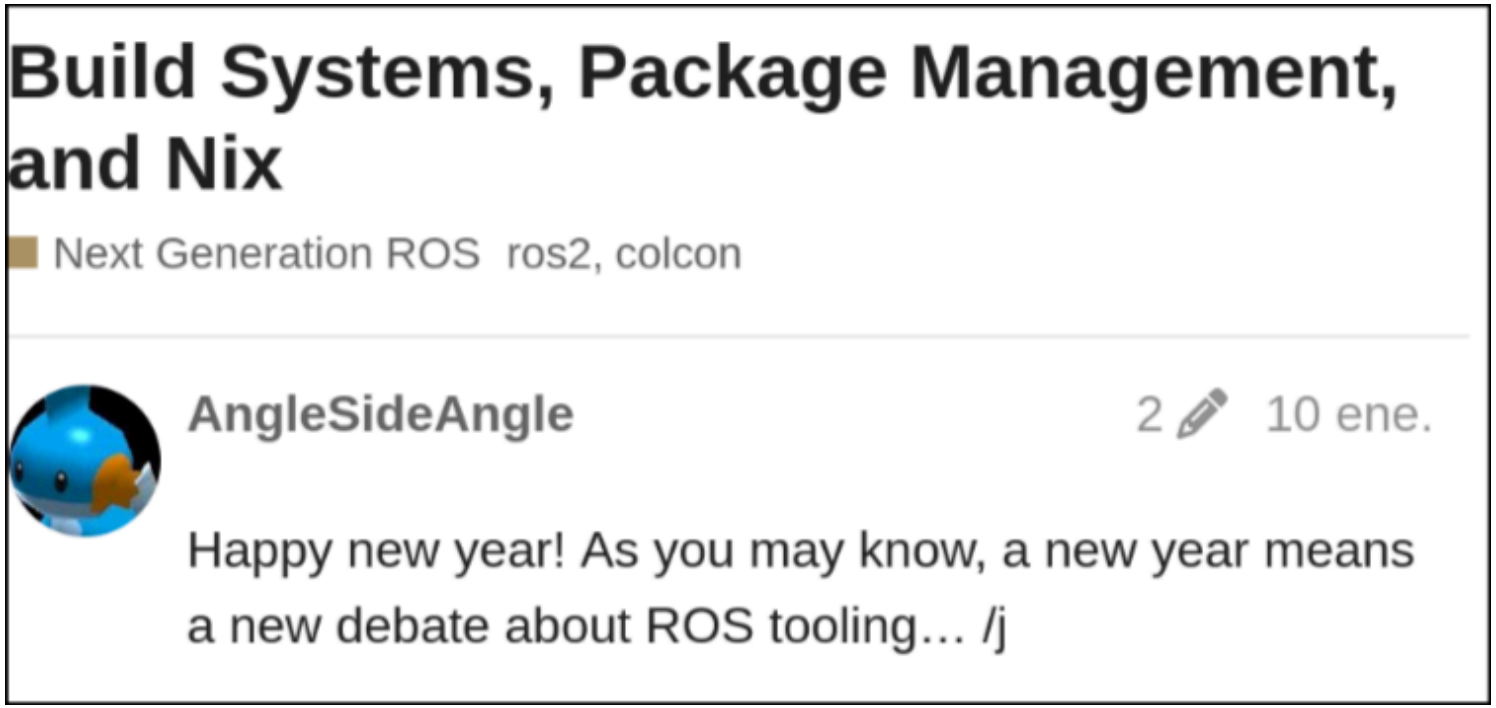

Figure 2: Grade A level trolling by Motorsports

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- Work undergoing to rewrite ros2nix in Motorsports
- Failure to keep pace with these developments reduces our research competitiveness, puts our build system in jeopardy of deprecation, and leaves our OPSEC vulnerable to upstream security issues

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- Gazebo/VRX simulation natively in Nix

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  - Use Haskell or another functional language for rapid theorizing and testing, independent of main codebase
- Fully vision-based autonomous systems
  - Station keeping would make a good R&D study of the feasibility of this

R&D subteam?

3.3 Further Reading

More to come on this in the future...

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This report is entirely open-access and open-source. You are welcome to contribute.
https://github.com/arcturusNavigation/tdr

4. References

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