Package URL and Version Range spec

Towards (mostly) universal dependency resolution

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- ScanCode and AboutCode projects lead and maintainer
- Creator of **Package URL**, co-founder of **SPDX**, ClearlyDefined
- FOSS veteran, long time **Google Summer of Code** mentor
- Co-founder and CTO of nexB Inc., makes of DejaCode
- Weird facts and claims to fame
  - Signed off on the **largest deletion of lines of code** in the **Linux kernel** (but these were only comments)
  - Unrepentant **code hoarder**. Had 60,000+ GH forks now down only to 20K forks
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Things are getting hairy and complex!!

- Ever **more FOSS packages** are reused
  - *10x to 100x more than a few years ago*
  - *Yes! we can really build applications from components!*
- Complex stacks with **multiple tech and languages**
  - Deep dependency trees
  - Dependencies on both application and system packages
- **Unstated dependencies** across
  - package **ecosystem** boundaries
  - **system** and **application** boundaries
- **More bugs and vulnerabilities!**

How can we deal with this complexity?

- ▷ Hand crafted, good old **README** with installation instructions
  - Install these debian packages, these npm packages and these Python packages
- ▷ **Replace all package managers with one to rule them all**

  Gain total control, all the way down with ...
- ▷ ... massive mono repo and "hermetic" build system
  - Big tech use these with Bazel or Buck
- ▷ ... general purpose package managers
  - Like Spack or Conda
- ▷ ... "functional" package managers
  - Like nix or guix

What is dependency resolution?

- Start with **package** you directly depend on
  - name & version (or version range)
- Access some **package** index or metadata source
  - collect all known versions of the package
- Select one **version** that matches the range you need
- For this version, collect the packages it **depends** on
  - names and versions (or version range)
- **Repeat recursively**
- Update selected **names and versions** as needed until consistent
  - Can be involved algos using sat solvers, backtracking, etc.
- ***Finally install these packages (not today's scope)***

The many curious ways of versioning

- ▷ Resolving package dependencies
  - "I require package <ABC>, version 2.0 or later versions"
- ▷ Affected vulnerable versions
  - "vulnerability CVE-2021-1 affects <XYZ>, version 3.1 and version 4.2 but not version 5"
- ▷ **Version numbers should be boring**
- ▷ Yet each ecosystem has its own way for version and range!

Debian, RPM, npm, PyPI, Ruby, etc. have their different notations using comparators **>, < or =**, or **tilde** ~ or **caret** ^ or **star** *

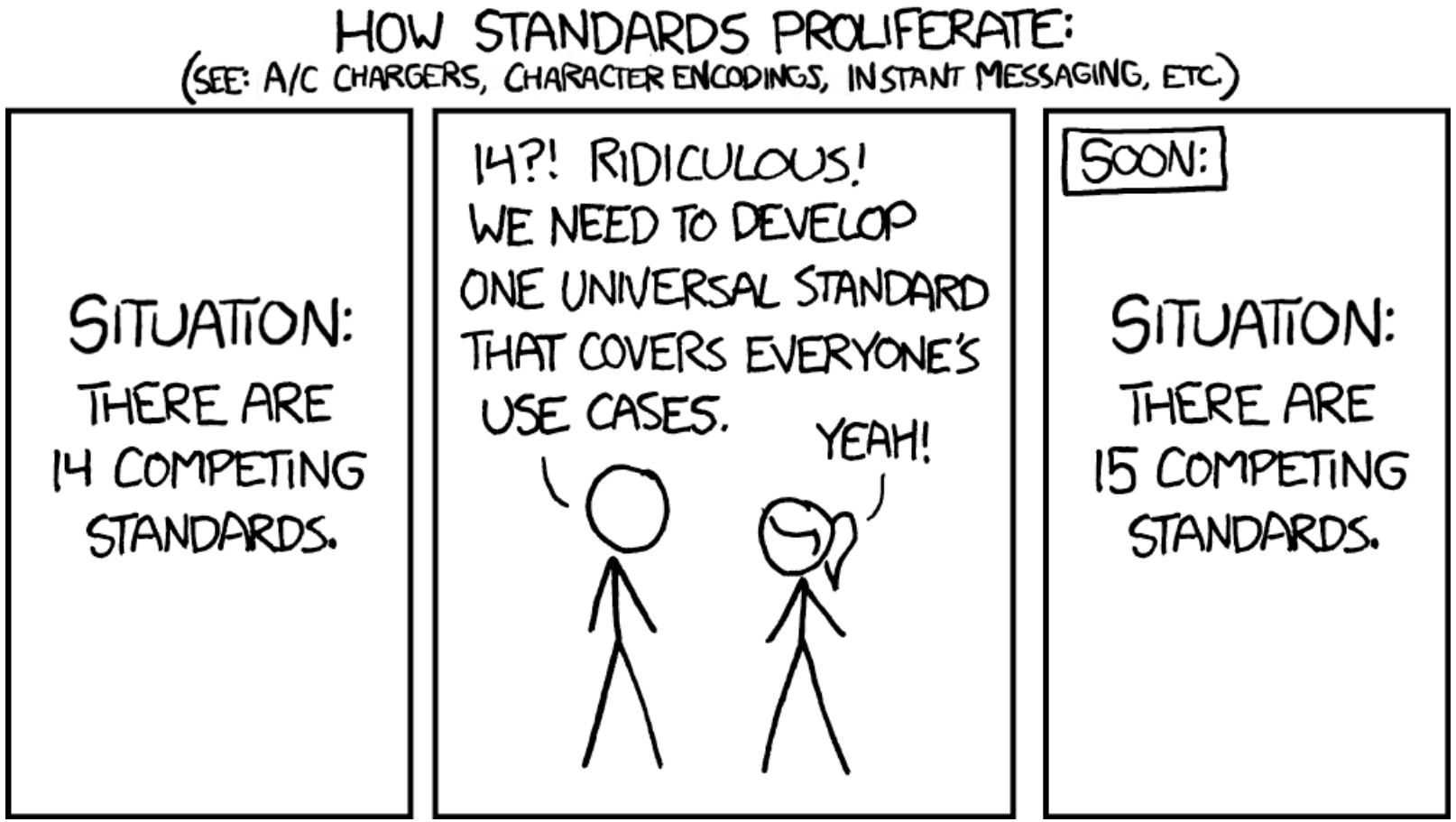
- ▷ Each resolve a dependency version in a range differently

What if ....

- ▷ We could express a dependency in **a mostly universal** way?
- ▷ And not replace all package managers BUT rather rule them all

- ▷ Use **Package URL "purl"** to name a package across ecosystem
- ▷ Add new **"vers" Version Range Spec** for ranges
  - For any ecosystem, building on Package URL "package type"
  - Simplified comparators set: >, <, =, !=, <=, >=
  - Ecosystem-specific version comparison
- ▷ Designed for **dependency** ranges AND **vulnerability** ranges

We need new standards to rule them all!



Credits: https://xkcd.com/927/

Package URL (purl)

- Problem: Each package type/ecosystem has its own conventions to identify, locate and provision software packages
- Solution: An expressive **package-url string**, minimalist yet obvious
- Identify & locate software packages reliably across tools and languages.

  `pkg:npm/foobar@12.3.1`

  `pkg:pypi/django@1.11.1`
- Started with ScanCode and VulnerableCode and now adopted in many places
- Now a **de-facto standard** used in ORT, OSSF OSV, CycloneDX, SPDX, Sonatype OSSIndex, GitHub and many places.
- Libraries in Java (multiple), PHP, Go, Python, JavaScript, Ruby, Swift, Rust, .Net,
- Recommended by the US NTIA as an SBOM package identifier
- See https://github.com/package-url/purl-spec

Package URL in the news this week

"Component verification and vulnerability reporting are supported by some SBOM data formats today. Globally unique identifiers is a work in process supported by the leading data formats for package URLs (PURLs)."

https://linuxfoundation.org/wp-content/uploads/LFResearch_SBOM_Report_final.pdf

Software Bill of Materials (SBOM) and Cybersecurity Readiness

January 2022

Stephen Hendrick, VP Research, The Linux Foundation

Version Range Spec (vers)

- Problem: Each package type/ecosystem has its own convention to specify version ranges
- Solution: An expressive **version range string**, minimalist yet obvious
- Specify version ranges reliably across tools and languages for deps **and** vulnerabilities.

  `vers:npm/1.2.3|>=2.0.0|<5.0.0`

  `vers:pypi/0.0.1|0.0.2|0.0.3|1.0|2.0pre1`

- A version range specifier ("vers") is a URI string using the vers scheme and this syntax:

  `vers:<versioning-scheme>/<version-constraint>|<version-constraint>|...`

- Started with VulnerableCode with "univers" library and now used in CycloneDX
  - Goal is to be a useful adjunct to purl
- Can pave the way to universal dependency resolution engines
  - Would still need to have access to all the package versions... working on it!
- See https://github.com/package-url/purl-spec/blob/version-range-spec/VERSION-RANGE-SPEC.rst

Putting it all together

A mostly universal package name (**purl**) with a mostly universal version range (**vers**) opens up many possibilities:

- **Store vulnerable version ranges and evaluate later if a version is vulnerable**
  - Prototype in univers library and VulnerableCode
  - https://github.com/nexb/vulnerablecode
  - https://github.com/nexB/univers
- **Build a multi package installer for many ecosystems**
  - Prototype toy at https://gist.github.com/pombredanne/d3585617882f91d9316be5ce5eddf190
- **Write mostly universal dependency declarations**
  - Soon in https://github.com/nexB/scancode-toolkit
- **Write a mostly universal dependency resolver?**
  - Say goodbye to README installation instructions!

An incremental approach instead of replacing everything

SCA AUTOMATION IS HARD

- But it is nearly **impossible** if no one speaks the same language
- To de-babelize this, **we need** shared **names for:**
  - Licenses
  - Packages
  - Versions
  - Vulnerabilities
  - Version control references

The Naming of Cats is a difficult matter

- **License** names
  - Mostly solved with **SPDX license ids** and **expressions**
  - Plus scancode-licensedb DB of most FOSS licenses
- **Software package** names
  - Mostly solved with **Package URL** emerging as a de-facto standard
- **Version range** notation for dependencies and vulnerable ranges
  - New mini spec for **Version Range Specifiers**
- **Vulnerability** identifiers
  - Mostly solved with NVD's **CVE** and aliases
- **Version control system** references
  - Likely solved with **VCS URLs** adapted from Python pip, now in SPDX

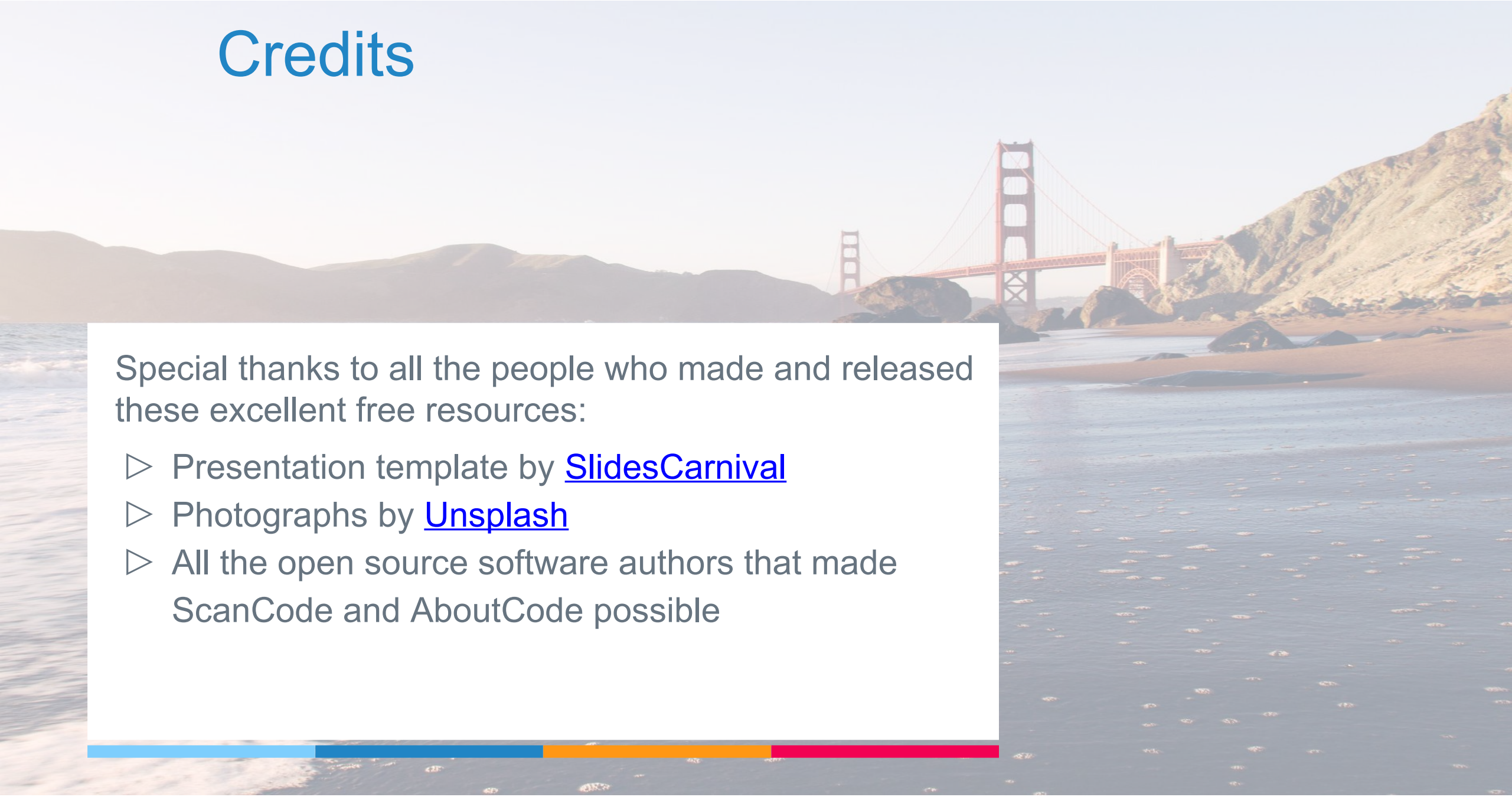
Credit https://www.severnedgevets.co.uk/pets/advice/advice-new-kitten-owners
Credit: T.S. Eliot, "Old Possum's Book of Practical Cats"

If you want to help

You can contribute code, time, docs (or cash?)

- Use these fine FOSS tools and specs
  - https://github.com/package-url
  - https://www.aboutcode.org/
  - https://github.com/nexB/
- Join the conversation at
  - https://gitter.im/aboutcode-org
- Donate at
  - https://opencollective.com/aboutcode

Credits



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