Core Infrastructure Initiative (CII)
Best Practices Badge: 1.5 Years Later

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It is *not* the case that “all OSS* is insecure” … or that “all OSS is secure”

- Just like all other software, some OSS is (relatively) secure.. and some is not

Heartbleed vulnerability in OpenSSL

- Demonstrated in 2014 that some widely-used OSS didn’t follow commonly-accepted practices & needed investment for security

Linux Foundation created Core Infrastructure Initiative (CII) in 2014

- “to fund and support critical elements of the global information infrastructure”
- “CII is transitioning from point fixes to holistic solutions for open source security”

*OSS=Open source software*
OSS tends to be more secure if it follows good security practices, undergoes peer review, etc.

- How can we encourage good practices?
- How can anyone know good practices are being followed?

**Badging project approach:**

- Identified a set of best practices for OSS projects
  - For *production* of OSS (for *license compliance*, see OpenChain)
  - Based on existing materials & practices
- Created web application: OSS projects self-certify
  - If OSS project meets criteria, it gets a badge (scales!)
  - No cost, & independent of size / products / services / programming language
  - Self-certification mitigated by automation, public display of answers (for criticism), LF spot-checks, LF can override
To get your OSS project a badge, go to https://bestpractices.coreinfrastructure.org/
Criteria

- Three badge levels (passing, silver, gold)
  - For higher levels, must meet previous level
- Passing:
  - Captures what well-run projects typically already do
  - Not “they should do X, but no one does that”
- 66 criteria in 6 groups:
  - Basics
  - Change Control
  - Reporting
  - Quality
  - Security
  - Analysis

Source:
Badge scoring system

To obtain a badge, all:
- MUST and MUST NOT criteria (42/66) must be met
- SHOULD (10/66) met, OR unmet with justification
  - Users can see those justifications & decide if that’s enough
- SUGGESTED (14/66) considered (met or unmet)
  - People don’t like admitting they didn’t do something
- In some cases, URL required in justification (to point to evidence; 8/66 require this)
Initial announcement

- General availability announced May 2016
- Early badge holders:
  - BadgeApp (itself!)
  - Node.js
  - Linux kernel
  - curl
  - GitLab
  - OpenSSL (pre-Heartbleed missed 1/3 criteria)
  - Zephyr project

Source: https://bestpractices.coreinfrastructure.org/projects
Some major projects with a best practice badge:
CII badges are getting adopted!

Over 1000 projects participating!

All projects

Over 100 passing!

Projects with non-trivial progress

Source: https://bestpractices.coreinfrastructure.org/project_stats as of 2017-09-19
Some newer badge holders (since 2017-02-08)

- Kubernetes
- libpki
- Ipsilon (ID provider)
- phpMyAdmin
- flawfinder
- OWASP dependency-check
- collectd
- Prometheus (monitoring/alerting)
- LibreNMS (network monitoring)
- LXC - linux containers
- lxd (Linux container manager)
- Xen
- Viua virtual machine
- Umoci (modify open container images)
- Iroha (decentralized ledger)
- Hyperledger Sawtooth Distributed Ledger
- Hyperledger Fabric
Sample impacts of CII badge process (1 of 2)

- OWASP ZAP (web app scanner)
  - Simon Bennetts: “[it] helped us improve ZAP quality… [it] helped us focus on [areas] that needed most improvement.”
  - Change: Significantly improved automated testing

- CommonMark (Markdown in PHP) changes:
  - TLS for the website (& links from repository to it)
  - Publishing the process for reporting vulnerabilities

- OPNFV (open network functions virtualization)
  - Change: Replaced no-longer-secure crypto algorithms

- JSON for Modern C++
  - “I really appreciate some formalized quality assurance which even hobby projects can follow.”
  - Change: Added explicit mention how to privately report errors
  - Change: Added a static analysis check to continuous integration script

Source: https://github.com/coreinfrastructure/best-practices-badge/wiki/Impacts
Sample impacts of CII badge process (2 of 2)

- **BRL-CAD**
  - Probably would have taken an hour uninterrupted, getting to 100% passing was relatively easy
  - Website certificate didn’t match our domain, fixed

- **POCO C++ Libraries**
  - “… thank you for setting up the best practices site. It was really helpful for me in assessing the status…”
  - Updated the CONTRIBUTING.md file to include a statement on reporting security issues
  - Updated the instructions for preparing a release in the Wiki to include running clang-analyzer
  - Enabled HTTPS for the project website

- **GNU Make**
  - HTTPS. Convinced Savannah to support HTTPS for repositories (it supported HTTPS for project home pages)

Source: https://github.com/coreinfrastructure/best-practices-badge/wiki/Impacts
Biggest challenges today for getting a badge

- All projects 90%+ but not passing (2017-09-06)
  - 74 projects. MUST with Unmet or “?” => Top 10 challenges:

<table>
<thead>
<tr>
<th>#</th>
<th>Criterion</th>
<th>%miss</th>
<th>Old rank#</th>
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<td>tests_are_added</td>
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<tr>
<td>4</td>
<td>vulnerability_report_private</td>
<td>15%</td>
<td>7</td>
</tr>
<tr>
<td>5</td>
<td>test_policy</td>
<td>14%</td>
<td>4</td>
</tr>
<tr>
<td>6</td>
<td>dynamic_analysis_fixed</td>
<td>14%</td>
<td>6</td>
</tr>
<tr>
<td>7</td>
<td>know_common_errors</td>
<td>12%</td>
<td>8</td>
</tr>
<tr>
<td>8</td>
<td>static_analysis</td>
<td>12%</td>
<td>5</td>
</tr>
<tr>
<td>9</td>
<td>know_secure_design</td>
<td>11%</td>
<td>9</td>
</tr>
<tr>
<td>10</td>
<td>delivery_unsigned</td>
<td>9%</td>
<td>15</td>
</tr>
</tbody>
</table>

Generally same challenges as 2017-02-06!
More projects are adding tests (good), so tests are *slightly* less common a problem
Tests

- **Criteria**
  - #1 The project MUST have evidence that such tests are being added in the most recent major changes to the project. [tests_are_added]
  - #4 The project MUST have a general policy (formal or not) that as major new functionality is added, tests of that functionality SHOULD be added to an automated test suite. [test_policy]

- **Automated testing is important**
  - Quality, supports rapid change, supports updating dependencies when vulnerability found
  - No coverage level required – just get started
Vulnerability reporting

Criteria

- #2 “The project MUST publish the process for reporting vulnerabilities on the project site.” [vulnerability_report_process]
- #8 “If private vulnerability reports are supported, the project MUST include how to send the information in a way that is kept private.” [vulnerability_report_private]

Just tell people how to report!

- In principle easy to do – but often omitted
- Projects need to decide how
#3 “The project sites (website, repository, and download URLs) MUST support HTTPS using TLS.” [sites_https]

Details:

- You can get free certificates from Let's Encrypt.
- Projects MAY implement this criterion using (for example) GitHub pages, GitLab pages, or SourceForge project pages.
- If you are using GitHub pages with custom domains, you MAY use a content delivery network (CDN) as a proxy to support HTTPS.

We’ve been encouraging hosting systems to support HTTPS
#5 “At least one static code analysis tool MUST be applied to any proposed major production release of the software before its release, if there is at least one FLOSS tool that implements this criterion in the selected language.” [static_analysis]

- A static code analysis tool examines the software code (as source code, intermediate code, or executable) without executing it with specific inputs.

#6 “All medium and high severity exploitable vulnerabilities discovered with dynamic code analysis MUST be fixed in a timely way after they are confirmed.” [dynamic_analysis_fixed]

- Early versions didn’t allow “N/A”; this has been fixed.
Know secure development

- Criteria
  - #8 “The project MUST have at least one primary developer who knows how to design secure software.” [know_secure_design]
  - #9 “At least one of the primary developers MUST know of common kinds of errors that lead to vulnerabilities in this kind of software, as well as at least one method to counter or mitigate each of them.” [know_common_errors]
- Specific list of requirements given – doesn’t require “know everything”
- Perhaps need short “intro” course material?
#10 “The project MUST include reference documentation that describes its external interface (both input and output).”

Some OSS projects have good documentation – but some do not
Good news

- Many criteria are widely met, e.g.:
  - Use of version control - repo_track
  - Process for submitting bug reports - report_process
  - No unpatched vulnerabilities of medium or high severity publicly known for more than 60 days - vulnerabilities_fixed_60_days
Higher-level criteria: Silver & Gold

- Have developed criteria for higher-level badges
  - Merged from proposals, NYC 2016 brainstorm, OW2, Apache maturity model, etc.
  - Again, not “they should do X, but no one does that”
  - Formally announced June 19, 2017

- Silver (formerly “passing+1”)
  - More challenging than “passing”
  - Expected to be achievable by single-person projects

- Gold (formerly “passing+2”)
  - Even more challenging
  - *Not* necessarily achievable by single-person projects

Source: CII Best Practices Badge Program Announces Higher-level Certification and Expanded Language Support
Silver: Sample criteria (1 of 2)

- The project MUST clearly define and document its project governance model (the way it makes decisions, including key roles).
- The project MUST be able to continue with minimal interruption if any one person is incapacitated or killed… [you] MAY do this by providing keys in a lockbox and a will providing any needed legal rights (e.g., for DNS names).
- The project MUST have FLOSS automated test suite(s) that provide at least 80% statement coverage if there is at least one FLOSS tool that can measure this criterion in the selected language.
- The project MUST automatically enforce its selected coding style(s) if there is at least one FLOSS tool that can do so in the selected language(s).
- The project MUST implement secure design principles (from "know_secure_design"), where applicable…
The project results MUST check all inputs from potentially untrusted sources to ensure they are valid (a whitelist), and reject invalid inputs, if there are any restrictions on the data at all. [input_validation]

The project MUST cryptographically sign releases of the project results intended for widespread use, and there MUST be a documented process explaining [how to] obtain the public signing keys and verify the signature(s)… [signed_releases]

The project MUST provide an assurance case that justifies why its security requirements are met. [It MUST…] [assurance_case]

The project MUST use at least one static analysis tool … to look for common vulnerabilities… , if there is at least one FLOSS tool that can… [static_analysis_common_vulnerabilities]

Projects MUST monitor or periodically check their external dependencies (including convenience copies) to detect known vulnerabilities, and fix exploitable vulnerabilities or verify them as unexploitable. [dependency_monitoring]
The project MUST require two-factor authentication (2FA) for developers for changing a central repository or accessing sensitive data (such as private vulnerability reports)... [require_2FA]

The project MUST have at least 50% of all proposed modifications reviewed before release by a person other than the author... [two_person_review]

The project MUST have a "bus factor" of 2 or more. [bus_factor]

The project MUST have a reproducible build... [build_reproducible]

The project MUST apply at least one dynamic analysis tool to any proposed major production release of the software before its release. [dynamic_analysis]

The project MUST have performed a security review within the last 5 years. This review MUST consider the security requirements and security boundary. [security_review]

Hardening mechanisms MUST be used in the software produced by the project so that software defects are less likely to result in security vulnerabilities. [hardening]
Statistics about the criteria themselves

<table>
<thead>
<tr>
<th>Level</th>
<th>Total active</th>
<th>MUST</th>
<th>SHOULD</th>
<th>SUGGESTED</th>
<th>Allow N/A</th>
<th>Met justification or URL required</th>
<th>Includes details</th>
<th>New at this level</th>
</tr>
</thead>
<tbody>
<tr>
<td>Passing</td>
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<td>42</td>
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<td>14</td>
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<td>9</td>
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<td>1</td>
<td>39</td>
<td>54</td>
<td>38</td>
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<td>Gold</td>
<td>23</td>
<td>21</td>
<td>2</td>
<td>0</td>
<td>9</td>
<td>21</td>
<td>15</td>
<td>14</td>
</tr>
</tbody>
</table>

There are not a lot of gold criteria, but they’re challenging.

Source: https://bestpractices.coreinfrastructure.org/criteria as of 2017-09-10
Silver is not a common badge level today, but behind-the-scenes some projects are progressing towards it
Natural languages supported

- English (en)
- Chinese (Simplified) / 简体中文 (zh-CN)
- French / Français (fr)
- German / Deutsch (de)
- Japanese / 日本語 (ja)
- Russian / Русский (ru)

Our sincere thanks to all the hard-working translators!!

Even if you can’t understand the detailed justifications, you can see the criteria & claimed answers
**Tools mentioned in static_analysis justification**

- Coverity (55)
- Cppcheck (22)
- scan-build / clang static analyzer (22=9+8+4+1)
- Codacy (13)
- scrutinizer (8)
- pylint (7)
- Findbugs (6)
- ESLint (6)
- shellcheck (5)
- PMD (5)
- Sonarqube (4)
- pep8 (4)
- JSHint (4)
- golint (4)
- flake8 (4)
- Code Climate (4)
- Rubocop (3)
- PHPMD (3)
- PHPCS (3)

- sparse (2)
- Resharper (2)
- pyflakes (2)
- pycodestyle (2)
- perl::critic (2)
- mypy (2)
- gometalinter (2)
- bandit (2)
- Visual Studio static analyzer (1)
- Veracode (1)
- unused (1)
- TSLint (1)
- stylelint (1)
- software assurance marketplace (1)
- SASS-Lint (1)
- RATS (1)
- pychecker (1)
- PVS-Studio (1)
- pkglint (1)

- Php Inspections (1)
- PHPCPD (1)
- luacheck (1)
- license (1)
- JSLint (1)
- JSCS (1)
- IT4 (1) [presumably ITS4]
- ineffect (1)
- govet (1)
- Eastwood (1)
- credo (1)
- cpplint (1)
- Codebeat.co (1)
- Clojure.check (1)
- Brakeman (1)
- Bikeshed (1)
- bashisms (1)
- Find SecurityBugs (1)

205 projects (out of 1013) had non-blank entries (some >1 tool)

*Many* static analysis tools in use (security-focused & not)
IDA

Licenses (where 3+ projects indicate)

- MIT: 37%
- Apache-2.0: 13%
- GPL-3.0: 13%
- GPL-2.0: 7%
- OTHER: 6%
- BSD-3-Clause: 4%
- AGPL-3.0: 4%
- GPL-3.0+: 3%
- LGPL-3.0: 2%
- LGPL-2.1: 2%
- MPL-2.0: 1%
- GPL-2.0+: 1%
- BSD-2-Clause: 1%

This data is as of 2017-09-06 15:20ET
Licenses (where 3+ projects indicate)

- Permissive (MIT, Apache, BSD…)
- Weakly protective (LGPL, MPL…)
- Strongly protective (GPL…)
- Network protective (AGPL)
- OTHER

This data is as of 2017-09-06 15:20ET
Involved in OSS?

- If you lead an OSS project, what you do matters!
  - People depend on the software you create
  - The practices you apply affect the result
  - Secure or quality software is not an accident
  - Please try to get a badge, & show when you have it

- If you’re considering using an OSS project
  - Check on the project – should you use it?

- Open Source Security podcast episode 14:
  - “This… is one of the most important security things going on today… folks go get your badges and make the world a better place…”
In conclusion: Key URLs

- CII
  - https://www.coreinfrastructure.org
- CII best practices badge (get a badge):
  - https://bestpractices.coreinfrastructure.org/
- CII best practices badge project:
  - https://github.com/coreinfrastructure/best-practices-badge

My thanks to the many who reviewed or helped develop the badging criteria and/or the software to implement it. This includes: Mark Atwood, Tod Beardsley, Doug Birdwell, Alton(ius) Blom, Hanno Böck, enos-dandrea, Jason Dossett, David Drysdale, Karl Fogel, Alex Jordan (strugee), Sam Khakimov, Greg Kroah-Hartman, Dan Kohn, Charles Neill (cneill), Mark Rader, Emily Ratliff, Tom Ritter, Nicko van Someren, Daniel Stenberg (curl), Marcus Streets, Trevor Vaughan, Dale Visser, Florian Weimer
Backup
Open source software

- OSS: software licensed to users with these freedoms:
  - to *run* the program for any purpose,
  - to *study* and *modify* the program, and
  - to freely *redistribute* copies of either the original or modified program (without royalties to original author, etc.)

- Original term: “Free software” (confused with no-price)
- Other synonyms: libre sw, free-libre sw, FOSS, FLOSS
- Antonyms: proprietary software, closed software
- Widely used; OSS #1 or #2 in many markets
  - “… plays a more critical role in the DoD than has generally been recognized.” [MITRE 2003]

- OSS almost always *commercial* by law & regulation
  - Software licensed to general public & has non-government use → commercial software (in US law, per 41 USC 403)
A little about the CII

- Multi-million dollar project
  - Supported by many, e.g., Amazon Web Services, Adobe, Bloomberg, Cisco, Dell, Facebook, Fujitsu, Google, Hitachi, HP, Huawei, IBM, Intel, Microsoft, NetApp, NEC, Qualcomm, RackSpace, salesforce.com, and VMware

- Actions
  - Collaboratively identifies & funds OSS projects in need of assistance
  - Allows developers to continue their work under community norms
  - Transitioning from point fixes to holistic solutions for open source security
CII-funded investments in key OSS projects

- OpenSSL
  - Funded key developers: improving security, enabling outside reviews, & improving responsiveness
  - Working with the Open Crypto Audit Project, has retained the NCC Group to audit OpenSSL code

- OpenSSH

- GnuPG

- Network Time Protocol (NTP) daemon

- Linux Kernel Self Protection Project

- ...

Source: https://www.coreinfrastructure.org/grants
CII-funded projects with multi-project impacts

- The fuzzing project
- OWASP Zed Attack Proxy (ZAP) as a service
- False-Positive-Free Testing with Frama-C
- Reproducible builds
- CII census (project quantitative analysis)
- Best practices badge (focus today)
Mozilla Open Source Support (MOSS) relation

- Mozilla Open Source Support (MOSS) added Secure Open Source (SOS) track
  - Announced June 9, 2016
  - “supports security audits for open source software projects, and remedial work to rectify the problems found”
  - “support model is different from & complementary to CII. [CII focuses on] deeper-dive investments into core OS security infrastructure, while [SOS targets] OSS projects with lower-hanging fruit security needs.”
- CII complements other efforts like MOSS

Sources: https://wiki.mozilla.org/MOSS/Secure_Open_Source
https://blog.mozilla.org/blog/2016/06/09/help-make-open-source-secure/
Badge criteria must be…

- Relevant
- Attainable by typical OSS projects
- Clear
- Include security-related criteria
- Consensus of developers & users
  - Criteria & web app developed as OSS project
  - Built on existing work, e.g., Karl Fogel’s *Producing Open Source Software*
- Not hypocritical
  - Our web app must get its own badge!

Worked with several projects, including the Linux kernel & curl, to perform alpha test of criteria.
1. Basics
   - The software MUST be released as FLOSS*. [floss_license]
   - It is SUGGESTED that any required license(s) be approved by the Open Source Initiative (OSI). [floss_license_osi]

2. Change Control
   - The project MUST have a version-controlled source repository that is publicly readable and has a URL. [repo_public]
     - Details: The URL MAY be the same as the project URL. The project MAY use private (non-public) branches in specific cases while the change is not publicly released (e.g., for fixing a vulnerability before it is revealed to the public).

3. Reporting
   - The project MUST publish the process for reporting vulnerabilities on the project site. [vulnerability_report_process]
4. Quality

- If the software requires building for use, the project MUST provide a working build system that can automatically rebuild the software from source code. [build]
- The project MUST have at least one automated test suite that is publicly released as FLOSS (this test suite may be maintained as a separate FLOSS project). [test]
- The project MUST have a general policy (formal or not) that as major new functionality is added, tests of that functionality SHOULD be added to an automated test suite. [test_policy]
- The project MUST enable one or more compiler warning flags, a "safe" language mode, or use a separate "linter" tool to look for code quality errors or common simple mistakes, if there is at least one FLOSS tool that can implement this criterion in the selected language. [warnings]
5. Security

- At least one of the primary developers MUST know of common kinds of errors that lead to vulnerabilities in this kind of software, as well as at least one method to counter or mitigate each of them. [know_common_errors]
- The project's cryptographic software MUST use only cryptographic protocols and algorithms that are publicly published and reviewed by experts. [crypto_published]
- The project MUST use a delivery mechanism that counters MITM attacks. Using https or ssh+scp is acceptable. [delivery_mitm]
- There MUST be no unpatched vulnerabilities of medium or high severity that have been publicly known for more than 60 days. [vulnerabilities_fixed_60_days]
6. Analysis

- At least one static code analysis tool MUST be applied to any proposed major production release of the software before its release, if there is at least one FLOSS tool that implements this criterion in the selected language… [static_analysis]

- It is SUGGESTED that the {static code analysis} tool include rules or approaches to look for common vulnerabilities in the analyzed language or environment. [static_analysis_common_vulnerabilities]

- It is SUGGESTED that at least one dynamic analysis tool be applied to any proposed major production release of the software before its release. [dynamic_analysis]
 Badge criteria must NOT be...

- Will NOT require any specific products or services (especially proprietary ones)
  - We intentionally don’t require git or GitHub
  - That said, will automate many things if project *does* use GitHub
- Will NOT require or forbid any particular programming language
Criteria have different levels of importance

- **MUST (NOT)** – required (42/66)
- **SHOULD (NOT)** – sometimes valid to not do (10/66)
- **SUGGESTED** – common valid reasons, but at least consider it (14/66)

Criteria may have “details” (39/66)

- Give clarifications/examples, e.g., “MAY…”

Each criterion is named (lowercase underscore)

For each criterion, users answer:

- Status: Met, Unmet, Unknown (?), N/A*
- Justification: Markdown text. Usually optional

* N/A is only allowed for 21/66 criteria
BadgeApp security

- File “security.md” describes how we secure the web app
- Report vulnerabilities to designated people
- Requirements – simple, most data public
  - Passwords stored in database only as iterated salted hashes
- Design: Showed that we applied design principles
  - Simple, filter inputs
- Implementation
  - Checked that it counters all of OWASP top 10
  - Applied “Ruby on Rails Security Guide”
  - Hardened (e.g., hardening HTTP headers)
- Verification
  - Source code quality analyzer (rubocop, rails_best_practices), [static] source code weakness analyzer (brakeman), web application scanner (OWASP ZAP), 98% test coverage, OSS enables multi-person review
- Supply chain (reuse)
  - Consider before use, bundle-audit (check known vulns), license_finder
  - Strive to minimize/simplify transitive dependencies & size
- People

Source/more info: https://github.com/coreinfrastructure/best-practices-badge/blob/master/doc/security.md
OLD Biggest challenges (early 2017)

- Looked at all projects 90%+ but not passing
  - 52 projects. MUST with Unmet or “?” => Top 10 challenges:

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<td>9</td>
<td>know_secure_design</td>
<td>10%</td>
</tr>
<tr>
<td>10</td>
<td>documentation_interface</td>
<td>8%</td>
</tr>
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</table>

Changing to 75%+ (81 projects) top 10 list has a slightly different order but the set is the same, except that 75%+ adds warnings_fixed as its #10 & know_common_errors moves #8→#11.
EU-FOSSA project interactions with CII Badge

- EU-FOSSA = EU-Free and Open Source Software Auditing
  - 1M Euro project initiated by 2 Members of European Parliament
  - Executed by European Commission (the European Union's executive body)
  - Goal: invest into commonly used OSS which might need support in the security domain
- Intends to define a complete process to properly perform code reviews within the European Institutions
  - To execute one sample code review during Q3-Q4/2016
  - Sample results will determine if activity could become a continuous action of the European Institutions in the future
- FOSSA project exchanging experiences with CII
- FOSSA looking closely at the CII Badge criteria
  - During definition of metrics to analyze sustainability and security

A few notes on the BadgeApp

- “BadgeApp” is simple web application that implements the criteria (fill in form)
  - OSS (MIT license)
    - All libraries OSS & legal to add (checked with license_finder)
  - Simple Ruby on Rails app
  - Criteria info (text, category, etc.) in YAML

- Overall approach: Proactively counter mistakes
  - Mistakes happen; we use a variety of tools, automated test suite, processes to counter them

- Please contribute!
  - See its CONTRIBUTING.md for more
Badge holders as of 2017-02-08

- CommonMark (Markdown in PHP)
- Apache Libcloud
- Apache Syncope
- GnuPG
- phpMyAdmin
- pkgsrc
- openstack
- OWASP ZAP (web app scanner)
- OPNFV (open network functions virtualization)
- JSON for Modern C++
- NTPsec
- LibreOffice
- OpenUnison
- sqrl-server-base
- Blender
- dpkg
- libseccomp

Source: https://bestpractices.coreinfrastructure.org/projects?gteq=100&sort=achieved_passing_at