OWASP Top 10 - 2021

The Ten Most Critical Web Application Security Risks

https://owasp.org

TOC Table of Contents

Table of Contents

About OWASP

The Open Web Application Security Project (OWASP) is an open community dedicated to enabling organizations to develop, purchase, and maintain applications and APIs that can be trusted.

At OWASP, you'll find free and open:

- Application security tools and standards
- Cutting edge research
- Standard security controls and libraries
- Complete books on application security testing, secure code development, and secure code review
- Presentations and videos
- Cheat sheets on many common topics
- Chapters meetings
- Events, training, and conferences.
- Google Groups

Learn more at: https://www.owasp.org.

All OWASP tools, documents, videos, presentations, and chapters are free and open to anyone interested in improving application security.

We advocate approaching application security as a people, process, and technology problem, because the most effective approaches to application security require improvements in these areas.

OWASP is a new kind of organization. Our freedom from commercial pressures allows us to provide unbiased, practical, and cost-effective information about application security.

OWASP is not affiliated with any technology company, although we support the informed use of commercial security technology. OWASP produces many types of materials in a collaborative, transparent, and open way.

The OWASP Foundation is the non-profit entity that ensures the project's long-term success. Almost everyone associated with OWASP is a volunteer, including the OWASP board, chapter leaders, project leaders, and project members. We support innovative security research with grants and infrastructure.

Come join us!

Copyright and License

FW Foreword

How to use the OWASP Top 10 as a standard

The OWASP Top 10 is primarily an awareness document. However, this has not stopped organizations using it as a de facto industry AppSec standard since its inception in 2003. If you want to use the OWASP Top 10 as a coding or testing standard, know that it is the bare minimum and just a starting point.

One of the difficulties of using the OWASP Top 10 as a standard is that we document appsec risks, and not necessarily easily testable issues. For example, A04:2021-Insecure Design is beyond the scope of most forms of testing. Another example is testing in place, in use, and effective logging and monitoring can only be done with interviews and requesting a sampling of effective incident responses. A static code analysis tool can look for the absence of logging, but it might be impossible to determine if business logic or access control is logging critical security breaches. Penetration testers may only be able to determine that they have invoked incident response in a test environment, which are rarely monitored in the same way as production.

Here are our recommendations for when it is appropriate to use the OWASP Top 10:

Use Case	OWASP Top 10 2021	OWASP Application Security Verification Standard
Awareness	Yes	
Training	Entry level	Comprehensive
Design and architecture	Occasionally	Yes
Coding standard	Bare minimum	Yes
Secure Code review	Bare minimum	Yes
Peer review checklist	Bare minimum	Yes
Unit testing	Occasionally	Yes
Integration testing	Occasionally	Yes
Penetration testing	Bare minimum	Yes
Tool support	Bare minimum	Yes
Secure Supply Chain	Occasionally	Yes

We would encourage anyone wanting to adopt an application security standard to use the OWASP Application Security Verification Standard (ASVS), as it's designed to be verifiable and tested, and can be used in all parts of a secure development lifecycle.

The ASVS is the only acceptable choice for tool vendors. Tools cannot comprehensively detect, test, or protect against the OWASP Top 10 due to the nature of several of the OWASP Top 10 risks, with reference to A04:2021-Insecure Design. OWASP discourages any claims of full coverage of the OWASP Top 10, because it's simply untrue.

Project Sponsorship

Thank you to our sponsor - The OWASP Top 10 2021 team gratefully acknowledge the financial support of Secure Code Warrior and Just Eat.

Thank you to our data contributors - The following organizations (along with some anonymous donors) kindly donated data for over 500,000 applications to make this the largest and most comprehensive application security data set. Without you, this would not be possible: AppSec Labs, Cobalt.io, Contrast Security, GitLab, HackerOne, HCL, Technologies, Micro Focus, PenTest-Tools, Probely, Sqreen, Veracode & WhiteHat (NTT).

Welcome to the OWASP Top 10 - 2021!

Welcome to the latest installment of the OWASP Top 10! The OWASP Top 10 2021 is all-new, with a new graphic design and an available one-page infographic you can print or obtain from our home page.

A huge thank you to everyone that contributed their time and data for this iteration. Without you, this installment would not happen.

THANK YOU!

Methodology

This installment of the Top 10 is more data-driven than ever but not blindly data-driven. We selected eight of the ten categories from contributed data and two categories from the Top 10 community survey at a high level. We do this for a fundamental reason, looking at the contributed data is looking into the past. AppSec researchers take time to find new vulnerabilities and new ways to test for them. It takes time to integrate these tests into tools and processes. By the time we can reliably test a weakness at scale, years have likely passed. To balance that view, we use a community survey to ask application security and development experts on the front lines what they see as essential weaknesses that the data may not show yet.

There are a few critical changes that we adopted to continue to mature the Top 10.

How the categories are structured

A few categories have changed from the previous installment of the OWASP Top Ten. Here is a high-level summary of the category changes. Previous data collection efforts were focused on a prescribed subset of approximately 30 CWEs with a field asking for additional findings. We learned that organizations would primarily focus on just those 30 CWEs and rarely add additional CWEs that they saw. In this iteration, we opened it up and just asked for data, with no restriction on CWEs. We asked for the number of applications tested for a given year (starting in 2017), and the number of applications with at least one instance of a CWE found in testing. This format allows us to track how prevalent each CWE is within the population of applications. We ignore frequency for our purposes; while it may be necessary for other situations, it only hides the actual prevalence in the application population. Whether an application has four instances of a CWE or 4,000 instances is not part of the calculation for the Top 10. We went from approximately 30 CWEs to almost 400 CWEs to analyze in the dataset. We plan to do additional data analysis as a supplement in the future. This significant increase in the number of CWEs necessitates changes to how the categories are structured.

We spent several months grouping and categorizing CWEs and could have continued for additional months. We had to stop at some point. There are both root cause and symptom types of CWEs, where root cause types are like "Cryptographic Failure" and "Misconfiguration" contrasted to symptom types like "Sensitive Data Exposure" and "Denial of Service." We decided to focus on the root cause whenever possible as it's more logical for providing identification and remediation guidance. Focusing on the root cause over the symptom isn't a new concept; the Top Ten has been a mix of symptom and root cause. CWEs are also a mix of symptom and root cause; we are simply being more deliberate about it and calling it out. There is an average of 19.6 CWEs per category in this installment, with the lower bounds at 1 CWE for **A10:2021-Server-Side Request Forgery (SSRF)** to 40 CWEs in **A04:2021-Insecure Design**. This updated category structure offers additional training benefits as companies can focus on CWEs that make sense for a language/framework.

How the data is used for selecting categories

In 2017, we selected categories by incidence rate to determine likelihood, then ranked them by team discussion based on decades of experience for *Exploitability*, *Detectability* (also *likelihood*), and *Technical Impact*. For 2021, we want to use data for *Exploitability* and (*Technical*) *Impact* if possible.

We downloaded OWASP Dependency Check and extracted the CVSS Exploit, and Impact scores grouped by related CWEs. It took a fair bit of research and effort as all the CVEs have CVSSv2 scores, but there are flaws in CVSSv2 that CVSSv3 should address. After a certain point in time, all CVEs are assigned a CVSSv3 score as well. Additionally, the scoring ranges and formulas were updated between CVSSv2 and CVSSv3.

In CVSSv2, both *Exploit* and (*Technical*) *Impact* could be up to 10.0, but the formula would knock them down to 60% for *Exploit* and 40% for *Impact*. In CVSSv3, the theoretical max was limited to 6.0 for *Exploit* and 4.0 for *Impact*. With the weighting considered, the *Impact* scoring shifted higher, almost a point and a half on average in CVSSv3, and *Exploitability* moved nearly half a point lower on average.

There are 125k records of a CVE mapped to a CWE in the National Vulnerability Database (NVD) data extracted from OWASP Dependency Check, and there are 241 unique CWEs mapped to a CVE. 62k CWE maps have a CVSSv3 score, which is approximately half of the population in the data set.

For the Top Ten 2021, we calculated average *Exploit* and *Impact* scores in the following manner. We grouped all the CVEs with CVSS scores by CWE and weighted both *Exploit* and *Impact* scored by the percentage of the population that had CVSSv3 + the remaining population of CVSSv2 scores to get an overall average. We mapped these averages to the CWEs in the dataset to use as *Exploit* and (*Technical*) *Impact* scoring for the other half of the risk equation.

Why not just pure statistical data?

The results in the data are primarily limited to what we can test for in an automated fashion. Talk to a seasoned AppSec professional, and they will tell you about stuff they find and trends they see that aren't yet in the data. It takes time for people to develop testing methodologies for certain vulnerability types and then more time for those tests to be automated and run against a large population of applications. Everything we find is looking back in the past and might be missing trends from the last year, which are not present in the data.

Therefore, we only pick eight of ten categories from the data because it's incomplete. The other two categories are from the Top 10 community survey. It allows the practitioners on the front lines to vote for what they see as the highest risks that might not be in the data (and may never be expressed in data).

Why incidence rate instead of frequency?

There are three primary sources of data. We identify them as Human-assisted Tooling (HaT), Tool-assisted Human (TaH), and raw Tooling.

Tooling and HaT are high-frequency finding generators. Tools will look for specific vulnerabilities and tirelessly attempt to find every instance of that vulnerability and will generate high finding counts for some vulnerability types. Look at Cross-Site Scripting, which is typically one of two flavors: it's either a more minor, isolated mistake or a systemic issue. When it's a systemic issue, the finding counts can be in the thousands for a single application. This high frequency drowns out most other vulnerabilities found in reports or data.

TaH, on the other hand, will find a broader range of vulnerability types but at a much lower frequency due to time constraints. When humans test an application and see something like Cross-Site Scripting, they will typically find three or four instances and stop. They can determine a systemic finding and write it up with a recommendation to fix on an application-wide scale. There is no need (or time) to find every instance.

Introduction and Methodology

Why incidence rate instead of frequency?

Suppose we take these two distinct data sets and try to merge them on frequency. In that case, the Tooling and HaT data will drown the more accurate (but broad) TaH data and is a good part of why something like Cross-Site Scripting has been so highly ranked in many lists when the impact is generally low to moderate. It's because of the sheer volume of findings. (Cross-Site Scripting is also reasonably easy to test for, so there are many more tests for it as well).

In 2017, we introduced using incidence rate instead to take a fresh look at the data and cleanly merge Tooling and HaT data with TaH data. The incidence rate asks what percentage of the application population had at least one instance of a vulnerability type. We don't care if it was one-off or systemic. That's irrelevant for our purposes; we just need to know how many applications had at least one instance, which helps provide a clearer view of the testing is findings across multiple testing types without drowning the data in high-frequency results. This corresponds to a risk related view as an attacker needs only one instance to attack an application successfully via the category.

What is your data collection and analysis process?

We formalized the OWASP Top 10 data collection process at the Open Security Summit in 2017. OWASP Top 10 leaders and the community spent two days working out formalizing a transparent data collection process. The 2021 edition is the second time we have used this methodology.

We publish a call for data through social media channels available to us, both project and OWASP. On the OWASP Project page, we list the data elements and structure we are looking for and how to submit them. In the GitHub project, we have example files that serve as templates. We work with organizations as needed to help figure out the structure and mapping to CWEs.

We get data from organizations that are testing vendors by trade, bug bounty vendors, and organizations that contribute internal testing data. Once we have the data, we load it together and run a fundamental analysis of what CWEs map to risk categories. There is overlap between some CWEs, and others are very closely related (ex. Cryptographic vulnerabilities). Any decisions related to the raw data submitted are documented and published to be open and transparent with how we normalized the data.

We look at the eight categories with the highest incidence rates for inclusion in the Top 10. We also look at the Top 10 community survey results to see which ones may already be present in the data. The top two votes that aren't already present in the data will be selected for the other two places in the Top 10. Once all ten were selected, we applied generalized factors for exploitability and impact; to help rank the Top 10 2021 in a risk based order.

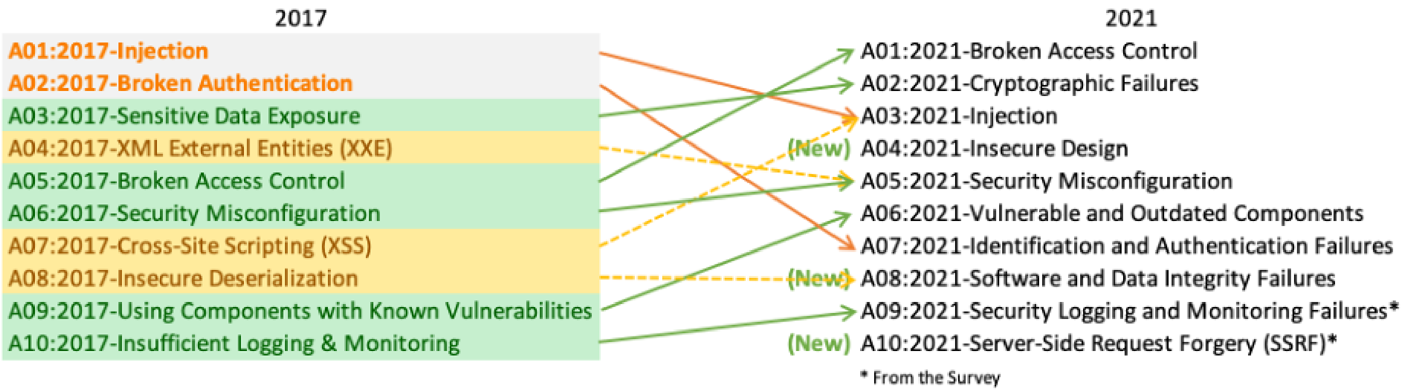
Data Factors

There are data factors that are listed for each of the Top 10 Categories, here is what they mean:

- CWEs Mapped: The number of CWEs mapped to a category by the Top 10 team.
- Incidence Rate: Incidence rate is the percentage of applications vulnerable to that CWE from the population tested by that org for that year.
- Weighted Exploit: The Exploit sub-score from CVSSv2 and CVSSv3 scores assigned to CVEs mapped to CWEs, normalized, and placed on a 10pt scale.
- Weighted Impact: The Impact sub-score from CVSSv2 and CVSSv3 scores assigned to CVEs mapped to CWEs, normalized, and placed on a 10pt scale.
- (Testing) Coverage: The percentage of applications tested by all organizations for a given CWE.
- Total Occurrences: Total number of applications found to have the CWEs mapped to a category.
- Total CVEs: Total number of CVEs in the NVD DB that were mapped to the CWEs mapped to a category.

What's changed in the Top 10 for 2021

There are three new categories, four categories with naming and scoping changes, and some consolidation in the Top 10 for 2021. We've changed names when necessary to focus on the root cause over the symptom.



- **A01:2021-Broken Access Control** moves up from the fifth position to the category with the most serious web application security risk; the contributed data indicates that on average, 3.81% of applications tested had one or more Common Weakness Enumerations (CWEs) with more than 318k occurrences of CWEs in this risk category. The 34 CWEs mapped to Broken Access Control had more occurrences in applications than any other category.
- **A02:2021-Cryptographic Failures** shifts up one position to #2, previously known as A3:2017-Sensitive Data Exposure, which was broad symptom rather than a root cause. The renewed name focuses on failures related to cryptography as it has been implicitly before. This category often leads to sensitive data exposure or system compromise.
- **A03:2021-Injection** slides down to the third position. 94% of the applications were tested for some form of injection with a max incidence rate of 19%, an average incidence rate of 3.37%, and the 33 CWEs mapped into this category have the second most occurrences in applications with 274k occurrences. Cross-site Scripting is now part of this category in this edition.
  A04:2021-Insecure Design is a new category for 2021, with a focus on risks related to design flaws. If we genuinely want to "move left" as an industry, we need more threat modeling, secure design patterns and principles, and reference architectures. An insecure design cannot be fixed by a perfect implementation as by definition, needed security controls were never created to defend against specific attacks.
- **A05:2021-Security Misconfiguration** moves up from #6 in the previous edition; 90% of applications were tested for some form of misconfiguration, with an average incidence rate of 4.5%, and over 208k occurrences of CWEs mapped to this risk category. With more shifts into highly configurable software, it's not surprising to see this category move up. The former category for A4:2017-XML External Entities (XXE) is now part of this risk category.

- **A06:2021-Vulnerable and Outdated Components** was previously titled Using Components with Known Vulnerabilities and is #2 in the Top 10 community survey, but also had enough data to make the Top 10 via data analysis. This category moves up from #9 in 2017 and is a known issue that we struggle to test and assess risk. It is the only category not to have any Common Vulnerability and Exposures (CVEs) mapped to the included CWEs, so a default exploit and impact weights of 5.0 are factored into their scores.
- **A07:2021-Identification and Authentication Failures** was previously Broken Authentication and is sliding down from the second position, and now includes CWEs that are more related to identification failures. This category is still an integral part of the Top 10, but the increased availability of standardized frameworks seems to be helping.
- **A08:2021-Software and Data Integrity Failures** is a new category for 2021, focusing on making assumptions related to software updates, critical data, and CI/CD pipelines without verifying integrity. One of the highest weighted impacts from Common Vulnerability and Exposures/Common Vulnerability Scoring System (CVE/CVSS) data mapped to the 10 CWEs in this category. A8:2017-Insecure Deserialization is now a part of this larger category.
- **A09:2021-Security Logging and Monitoring Failures** was previously A10:2017-Insufficient Logging & Monitoring and is added from the Top 10 community survey (#3), moving up from #10 previously. This category is expanded to include more types of failures, is challenging to test for, and isn't well represented in the CVE/CVSS data. However, failures in this category can directly impact visibility, incident alerting, and forensics.
- **A10:2021-Server-Side Request Forgery** is added from the Top 10 community survey (#1). The data shows a relatively low incidence rate with above average testing coverage, along with above-average ratings for Exploit and Impact potential. This category represents the scenario where the security community members are telling us this is important, even though it's not illustrated in the data at this time.