



OWASP API Security Top 10 2019

The Ten Most Critical API Security Risks



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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.
- Complete books on application security testing, secure code development, and secure code review.
- Presentations and [videos](#).
- [Cheat sheets](#) on many common topics.
- Standard security controls and libraries.
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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!

A foundational element of innovation in today's app-driven world is the Application Programming Interface (API). From banks, retail, and transportation to IoT, autonomous vehicles, and smart cities, APIs are a critical part of modern mobile, SaaS, and web applications and can be found in customer-facing, partner-facing, and internal applications.

By nature, APIs expose application logic and sensitive data such as Personally Identifiable Information (PII) and because of this, APIs have increasingly become a target for attackers. Without secure APIs, rapid innovation would be impossible.

Although a broader web application security risks Top 10 still makes sense, due to their particular nature, an API specific security risks list is required. API security focuses on strategies and solutions to understand and mitigate the unique vulnerabilities and security risks associated with APIs.

If you're familiar with the [OWASP Top 10 Project](#), then you'll notice the similarities between both documents: they are intended for readability and adoption. If you're new to the OWASP Top 10 series, you may be better off reading the [API Security Risks](#) and [Methodology and Data](#) sections before jumping into the Top 10 list.

You can contribute to OWASP API Security Top 10 with your questions, comments, and ideas at our GitHub project repository:

- <https://github.com/OWASP/API-Security/issues>
- <https://github.com/OWASP/API-Security/blob/master/CONTRIBUTING.md>

You can find the OWASP API Security Top 10 here:

- https://www.owasp.org/index.php/OWASP_API_Security_Project
- <https://github.com/OWASP/API-Security>

We wish to thank all the contributors who made this project possible with their effort and contributions. They are all listed in the [Acknowledgments section](#). Thank you!

Welcome to the OWASP API Security Top 10 - 2019!

Welcome to the first edition of the OWASP API Security Top 10. If you're familiar with the OWASP Top 10 series, you'll notice the similarities: they are intended for readability and adoption. Otherwise, consider visiting the [OWASP API Security Project wiki page](#), before digging deeper into the most critical API security risks.

APIs play a very important role in modern applications' architecture. Since creating security awareness and innovation have different paces, it's important to focus on common API security weaknesses.

The primary goal of the OWASP API Security Top 10 is to educate those involved in API development and maintenance, for example, developers, designers, architects, managers, or organizations.

In the [Methodology and Data](#) section, you can read more about how this first edition was created. In future versions, we want to involve the security industry, with a public call for data. For now, we encourage everyone to contribute with questions, comments and ideas at our [GitHub repository](#) or [Mailing list](#).

This is the first OWASP API Security Top 10 edition, which we plan to be updated periodically, every three or four years.

Unlike this version, in future versions, we want to make a public call for data, involving the security industry in this effort. In the [Methodology and Data](#) section, you'll find more details about how this version was built. For more details about the security risks, please refer to the [API Security Risks](#) section.

It is important to realize that over the last few years, applications' architecture has significantly changed. Currently, APIs play a very important role in this new architecture of microservices, Single Page Applications (SPAs), mobile apps, IoT, etc.

The OWASP API Security Top 10 was a required effort to create awareness about modern APIs security issues. It was only possible due to a great effort of several volunteers, all of them listed in the [Acknowledgments](#) section. Thank you!

The [OWASP Risk Rating Methodology](#) was used to do the risk analysis.

The table below summarizes the terminology associated with the risk score.

Threat Agents	Exploitability	Weakness Prevalence	Weakness Detectability	Technical Impact	Business Impacts
API Specific	Easy: 3	Widespread 3	Easy 3	Severe 3	Business Specific
	Average: 2	Common 2	Average 2	Moderate 2	
	Difficult: 1	Difficult 1	Difficult 1	Minor 1	

Note: This approach does not take the likelihood of the threat agent into account. Nor does it account for any of the various technical details associated with your particular application. Any of these factors could significantly affect the overall likelihood of an attacker finding and exploiting a particular vulnerability. This rating does not take into account the actual impact on your business. Your organization will have to decide how much security risk from applications and APIs the organization is willing to accept given your culture, industry, and regulatory environment. The purpose of the OWASP API Security Top 10 is not to do this risk analysis for you.

References

OWASP

- [OWASP Risk Rating Methodology](#)
- [Article on Threat/Risk Modeling](#)

External

- [ISO 31000: Risk Management Std](#)
- [ISO 27001: ISMS](#)
- [NIST Cyber Framework \(US\)](#)
- [ASD Strategic Mitigations \(AU\)](#)
- [NIST CVSS 3.0](#)
- [Microsoft Threat Modeling Tool](#)

API1:2019 - Broken Object Level Authorization	APIs tend to expose endpoints that handle object identifiers, creating a wide attack surface Level Access Control issue. Object level authorization checks should be considered in every function that accesses a data source using an input from the user.
API2:2019 - Broken Authentication	Authentication mechanisms are often implemented incorrectly, allowing attackers to compromise authentication tokens or to exploit implementation flaws to assume other user's identities temporarily or permanently. Compromising system's ability to identify the client/user, compromises API security overall.
API3:2019 - Excessive Data Exposure	Looking forward to generic implementations, developers tend to expose all object properties without considering their individual sensitivity, relying on clients to perform the data filtering before displaying it to the user.
API4:2019 - Lack of Resources & Rate Limiting	Quite often, APIs do not impose any restrictions on the size or number of resources that can be requested by the client/user. Not only can this impact the API server performance, leading to Denial of Service (DoS), but also leaves the door open to authentication flaws such as brute force.
API5:2019 - Broken Function Level Authorization	Complex access control policies with different hierarchies, groups, and roles, and an unclear separation between administrative and regular functions, tend to lead to authorization flaws. By exploiting these issues, attackers gain access to other users' resources and/or administrative functions.
API6:2019 - Mass Assignment	Binding client provided data (e.g., JSON) to data models, without proper properties filtering based on a whitelist, usually lead to Mass Assignment. Either guessing objects properties, exploring other API endpoints, reading the documentation, or providing additional object properties in request payloads, allows attackers to modify object properties they are not supposed to.
API7:2019 - Security Misconfiguration	Security misconfiguration is commonly a result of unsecure default configurations, incomplete or ad-hoc configurations, open cloud storage, misconfigured HTTP headers, unnecessary HTTP methods, permissive Cross-Origin resource sharing (CORS), and verbose error messages containing sensitive information.
API8:2019 - Injection	Injection flaws, such as SQL, NoSQL, Command Injection, etc. occur when untrusted data is sent to an interpreter as part of a command or query. The attacker's malicious data can trick the interpreter into executing unintended commands or accessing data without proper authorization.
API9:2019 - Improper Assets Management	APIs tend to expose more endpoints than traditional web applications, making proper and updated documentation highly important. Proper hosts and deployed API versions inventory also play an important role to mitigate issues such as deprecated API versions and exposed debug endpoints.
API10:2019 - Insufficient Logging & Monitoring	Insufficient logging and monitoring, coupled with missing or ineffective integration with incident response, allows attackers to further attack systems, maintain persistence, pivot to more systems to tamper with, extract, or destroy data. Most breach studies demonstrate the time to detect a breach is over 200 days, typically detected by external parties rather than internal processes or monitoring.

Threat Agents		Attack Vectors		Security Weakness		Impacts	
API Specific	Exploitability: 3	Prevalence: 3	Detectability: 2	Technical: 3	Business Specific		
<p>Attackers can exploit API endpoints that are vulnerable to broken object level authorization by manipulating the ID of an object that is sent within the request. This may lead to unauthorized access to sensitive data. This issue is extremely common in API-based applications because the server component usually does not fully track the client's state, and instead, relies more on parameters like object IDs, that are sent from the client to decide which objects to access.</p>		<p>This has been the most common and impactful attack on APIs. Authorization and access control mechanisms in modern applications are complex and wide-spread. Even if the application implements a proper infrastructure for authorization checks, developers might forget to use these checks before accessing a sensitive object. Access control detection is not typically amenable to automated static or dynamic testing.</p>		<p>Unauthorized access can result in data disclosure to unauthorized parties, data loss, or data manipulation. Unauthorized access to objects can also lead to full account takeover.</p>			

Is The API Vulnerable?

Object level authorization is an access control mechanism that is usually implemented at the code level to validate that one user can only access objects that they should have access to.

Every API endpoint that receives an ID of an object, and performs any type of action on the object, should implement object level authorization checks. The checks should validate that the logged-in user does have access to perform the requested action on the requested object.

Failures in this mechanism typically leads to unauthorized information disclosure, modification, or destruction of all data.

Example Attack Scenarios

Scenario #1

An e-commerce platform for online stores (shops) provides a listing page with the revenue charts for their hosted shops. Inspecting the browser requests, an attacker can identify the API endpoints used as a data source for those charts and their pattern `/shops/{shopName}/revenue_data.json`. Using another API endpoint, the attacker can get the list of all hosted shop names. With a simple script to manipulate the names in the list, replacing `{shopName}` in the URL, the attacker gains access to the sales data of thousands of e-commerce stores.

Scenario #2

While monitoring the network traffic of a wearable device, the following HTTP PATCH request gets the attention of an attacker due to the presence of a custom HTTP request header `X-User-Id: 54796`. Replacing the `X-User-Id` value with `54795`, the attacker receives a successful HTTP response, and is able to modify other users' account data.

How To Prevent

- Implement a proper authorization mechanism that relies on the user policies and hierarchy.
- Prefer not to use an ID that has been sent from the client, but instead use an ID that is stored in the session object when accessing a database record by the record ID.
- Use an authorization mechanism to check if the logged-in user has access to perform the requested action on the record in every function that uses an input from the client to access a record in the database.
- Prefer to use random and unpredictable values as GUIDs for records' IDs.
- Write tests to evaluate the authorization mechanism. Do not deploy vulnerable changes that break the tests.

References

External

- [CWE-284: Improper Access Control](#)
- [CWE-285: Improper Authorization](#)
- [CWE-639: Authorization Bypass Through User-Controlled Key](#)

API2:2019 Broken Authentication

API Specific		Business Specific	
Exploitability: 3		Technical: 3	
Prevalence: 2		Detectability: 2	
Authentication in APIs is a complex and confusing mechanism. Software and security engineers might have misconceptions about what are the boundaries of authentication and how to implement it correctly. In addition, the authentication mechanism is an easy target for attackers, since it's exposed to everyone. These two points makes the authentication component potentially vulnerable to many exploits.		There are two sub-issues: 1. Lack of protection mechanisms: APIs endpoints that are responsible for authentication must be treated differently from regular endpoints and implement extra layers of protection 2. Misimplementation of the mechanism: The mechanism is used / implemented without considering the attack vectors, or it's the wrong use case (e.g., an authentication mechanism designed for IoT clients might not be the right choice for web applications).	
Threat Agents		Impacts	
Attack Vectors		Security Weakness	

Is the API Vulnerable?

Authentication endpoints and flows are assets that need to be protected. "Forgot password / reset password" should be treated the same way as authentication mechanisms.

An API is vulnerable if it:

- Permits [credential stuffing](#) whereby the attacker has a list of valid usernames and passwords.
- Permits attackers to perform a brute force attack on the same user, without presenting captcha / account lockout mechanism.
- Permits weak passwords.
- Sends sensitive authentication details, such as auth tokens and password in the URL.
- Doesn't validate the authenticity of tokens.
- Accepts unsigned / weakly signed JWT tokens ("alg": "none") / doesn't validate their expiration date.
- Uses plain text, encrypted, or weakly hashed passwords.
- Uses weak encryption keys / API keys.

Example Attack Scenarios

Scenario #1

[Credential stuffing](#) (using [lists of known usernames/passwords](#)), is a common attack. If an application does not implement automated threat or credential stuffing protections, the application can be used as a password oracle (tester) to determine if the credentials are valid.

Scenario #2

An attacker starts the password recovery workflow by issuing a POST request to `/api/system/verification-codes` and by providing the username in the request body. Next an SMS token with 6 digits is sent to the victim's phone. Because the API does not implement a rate limiting policy, the attacker can test all possible combinations using a multi-threaded script, against the

/api/system/verification-codes/{smsToken} endpoint to discover the right token within a few minutes.

How To Prevent

- Make sure you know all the possible flows to authenticate to the API (mobile/ web/deep links that implement one-click authentication/etc)
- Ask your engineers what flows you missed.
- Read about your authentication mechanisms. Make sure you understand what and how they are used. OAuth is not authentication, and neither API keys .
- Don't reinvent the wheel in authentication, token generation, password storage. Use the standards.
- Credential recovery / forget password endpoints should be treated as login endpoints in terms of brute force, rate limiting and lockout protections.
- Use the [OWASP Authentication Cheatsheet](#)
- Where possible, implement multi-factor authentication.
- Implement anti brute force mechanisms to mitigate credential stuffing, dictionary attack and brute force attacks on your authentication endpoints. This mechanism should be stricter than the regular rate limiting mechanism on your API.
- Implement [account lockout](#) / captcha mechanism to prevent brute force against specific users. Implement weak-password checks.
- API keys should not be used for user authentication, but for [client app / project authentication](#).

References

OWASP

- [OWASP Key Management Cheat Sheet](#)
- [OWASP Authentication Cheatsheet](#)
- [Credential Stuffing](#)

External

- [CWE-798: Use of Hard-coded Credentials](#)

API3:2019 Excessive Data Exposure

Threat Agents		Attack Vectors		Security Weakness		Impacts		
API Specific	Exploitability: 3	Prevalence: 2	Detectability: 2	Technical: 2	Business Specific			
Exploitation of Excessive Data Exposure is simple, and is usually performed by sniffing the traffic to analyze the API responses, looking for sensitive data exposure that should not be returned to the user.		APIs rely on clients to perform the data filtering. Since APIs are used as data sources, sometimes developers try to implement them in a generic way without thinking about the sensitivity of the exposed data. Automatic tools usually can't detect this type of vulnerability because it's hard to differentiate between legitimate data returned from the API, and sensitive data that should not be returned without a deep understanding of the application.		Excessive Data Exposure commonly leads to exposure of sensitive data.				

Is the API Vulnerable?

The API returns sensitive data to the client by design. This data is usually filtered on the client side before being presented to the user. An attacker can easily sniff the traffic and see the sensitive data.

Example Attack Scenarios

Scenario #1

The mobile team uses the `/api/articles/{articleId}/comments/{commentId}` endpoint in the articles view to render comments metadata. Sniffing the mobile application traffic, an attacker finds out that other sensitive data related to comment's author is also returned. The endpoint implementation uses a generic `toJSON()` method on the `User` model, which contains PII, to serialize the object.

Scenario #2

An IOT-based surveillance system allows administrators to create users with different permissions. An admin created a user account for a new security guard that should only have access to specific buildings on the site. Once the security guard uses his mobile app, an API call is triggered to: `/api/sites/111/cameras` in order to receive data about the available cameras and show them on the dashboard. The response contains a list with details about cameras in the following format: `{"id": "xxx", "live_access_token": "xxxx-bbbbb", "building_id": "yyy"}`. While the client GUI shows only cameras which the security guard should have access to, the actual API response contains a full list of all the cameras in the site.

How To Prevent

- Never rely on the client side to perform sensitive data filtering.
- Review the responses from the API to make sure they contain only legitimate data.
- Explicitly define and enforce data returned by all API methods, including errors. Whenever possible: use schemas for responses, patterns for all strings and clear field names.
- Define all sensitive and personally identifiable information (PII) that your application stores and works with and review all API calls returning such information to see if these responses can be a security issue.

References

External

- [CWE-213: Intentional Information Exposure](#)

Threat Agents		Attack Vectors		Security Weakness		Impacts		
API Specific	Exploitability: 2	Prevalence: 3	Detectability: 3	Technical: 2	Business Specific			
Exploitation requires simple API requests. No authentication is required. Multiple concurrent requests can be performed from a single local computer or by using cloud computing resources.		It's common to find APIs that do not implement rate limiting or APIs where limits are not properly set.		Exploitation may lead to DoS, making the API unresponsive or even unavailable.				

Is the API Vulnerable?

API requests consume resources such as network, CPU, memory, and storage. The amount of resources required to satisfy a request greatly depends on the user input and endpoint business logic. Also, consider the fact that requests from multiple API clients compete for resources. An API is vulnerable if at least one of the following limits is missing or set inappropriately (e.g., too low/high).

- Execution timeouts
- Max allocable memory
- Number of file descriptors
- Number of processes
- Request payload size (e.g. uploads)
- Number of requests per client/resource
- Number of records per page to return in a single request response

Example Attack Scenarios

Scenario #1

An attacker uploads a large image by issuing a POST request to `/api/v1/images`. When the upload is complete, the API creates multiple thumbnails with different sizes. Due to the size of the uploaded image, available memory is exhausted during the creation of thumbnails and the API becomes unresponsive.

Scenario #2

We have an application that contains the users' list on a UI with a limit of 200 users per page. The users' list is retrieved from the server using the following query: `/api/users?page=1&size=100`. An attacker changes the `size` parameter to `200 000`, causing performance issues on the database. Meanwhile, the API becomes unresponsive and is unable to handle further requests from this or any other clients (aka DoS).

The same scenario might be used to provoke Integer Overflow or Buffer Overflow errors.

How To Prevent

- Docker makes it easy to limit [memory](#), [CPU](#), [number of restarts](#), [file descriptors](#), and [processes](#).
- Implement a limit on how often a client can call the API within a defined timeframe.
- For sensitive operations such as login or password reset, consider rate limits by API method (e.g., authentication), client (e.g., IP address), property (e.g., username).
- Notify the client when the limit is exceeded by providing the limit number and the time at which the limit will be reset.
- Add proper server-side validation for query string and request body parameters, specifically the one that controls the number of records to be returned in the response.
- Define and enforce maximum size of data on all incoming parameters and payloads such as maximum length for strings and maximum number of elements in arrays.
- If your API accepts compressed files check compression ratios before expanding the files to protect yourself against "zip bombs".

References

OWASP

- [Blocking Brute Force Attacks](#)
- [Docker Cheat Sheet - Limit resources \(memory, CPU, file descriptors, processes, restarts\)](#)
- [REST Assessment Cheat Sheet](#)

External

- [CWE-307: Improper Restriction of Excessive Authentication Attempts](#)
- [CWE-770: Allocation of Resources Without Limits or Throttling](#)
- “Rate Limiting (Throttling)” - [Security Strategies for Microservices-based Application Systems](#), NIST

Threat Agents		Attack Vectors		Security Weakness		Impacts	
API Specific	Exploitability: 3	Prevalence: 2	Detectability: 1	Technical: 2	Business Specific		
Exploitation requires the attacker to send legitimate API calls to the API endpoint that they should not have access to. These endpoints might be exposed to anonymous users or regular, non-privileged users. It's easier to discover these flaws in APIs since APIs are more structured, and the way to access certain functions is more predictable (e.g., replacing the HTTP method from GET to PUT, or changing the "users" string in the URL to "admins", or changing the value of a parameter like "is_admin" from "false" to "true").		Authorization checks for a function or resource are usually managed via configuration, and sometimes at the code level. Implementing proper checks can be a confusing task, since modern applications can contain many types of roles or groups and complex user hierarchy (e.g., sub-users, users with more than one role).		Such flaws allow attackers to access unauthorized functionality. Administrative functions are key targets for this type of attack.			

Is the API Vulnerable?

The best way to find broken function level authorization issues is to perform deep analysis of the authorization mechanism, while keeping in mind the user hierarchy, different roles or groups in the application, and asking the following questions:

- Can a regular user access administrative endpoints?
- Can a user perform sensitive actions (e.g., creation, modification, or erasure) that they should not have access to by simply changing the HTTP method (e.g., from GET to DELETE)?
- Can a user from group X access a function that should be exposed only to users from group Y, by simply guessing the endpoint URL and parameters (e.g., `/api/v1/users/export_all`)?

Don't assume that an API endpoint is regular or administrative only based on the URL path.

While developers might choose to expose most of the administrative endpoints under a specific relative path, like `api/admins`, it's very common to find these administrative endpoints under other relative paths together with regular endpoints, like `api/users`.

Example Attack Scenarios

Scenario #1

During the registration process to an application that allows only invited users to join, the mobile application triggers an API call to `GET /api/invites/{invite_guid}`. The response contains a JSON with details about the invite, including the user's role and the user's email.

An attacker duplicated the request and manipulated the HTTP method and endpoint to `POST /api/invites/new`. This endpoint should only be accessed by administrators using the admin console, which does not implement function level authorization checks.

The attacker exploits the issue and sends himself an invite to create an admin account:


```
POST /api/invites/new
{"email":"hugo@malicious.com","role":"admin"}
```

Scenario #2

An API contains an endpoint that should be exposed only to administrators - GET `/api/admin/v1/users/all`. This endpoint returns the details of all the users of the application and does not implement function-level authorization checks. An attacker who learned the API structure takes an educated guess and manages to access this endpoint, which exposes sensitive details of the users of the application.

How To Prevent

Your application should have a consistent and easy to analyze authorization module that is invoked from all your business functions. Frequently, such protection is provided by one or more components external to the application code.

- The enforcement mechanism(s) should deny all access by default, requiring explicit grants to specific roles for access to every function.
- Review your API endpoints against function level authorization flaws, while keeping in mind the business logic of the application and groups hierarchy.
- Make sure that all of your administrative controllers inherit from an administrative abstract controller that implements authorization checks based on the user's group/role.
- Make sure that administrative functions inside a regular controller implements authorization checks based on the user's group and role.

References

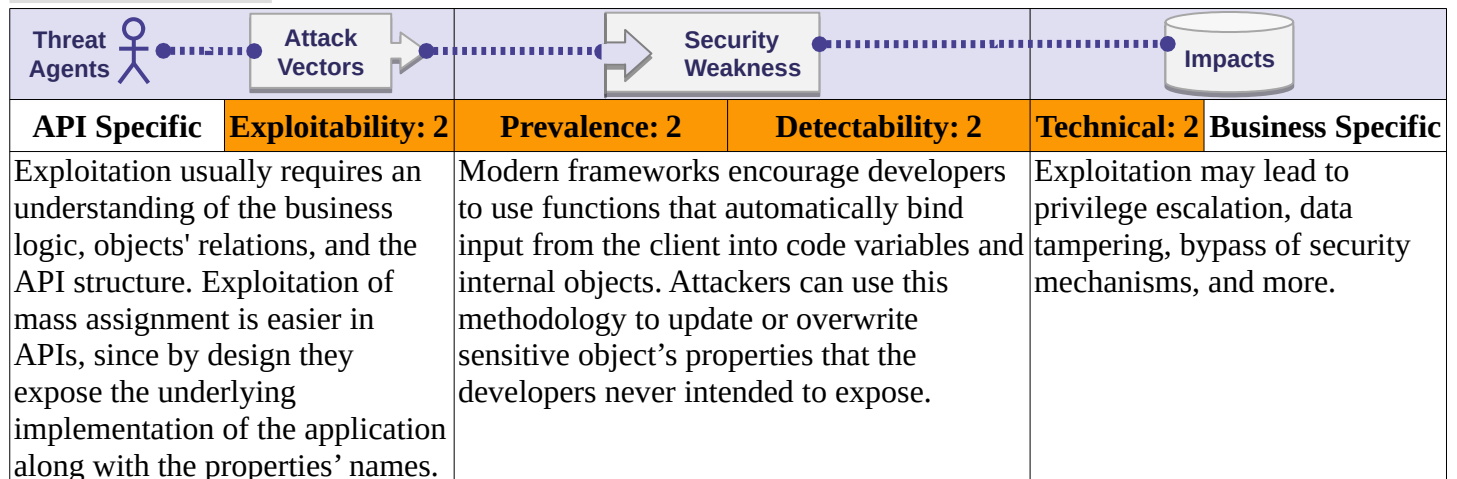
OWASP

- [OWASP Article on Forced Browsing](#)
- [OWASP Top 10 2013-A7-Missing Function Level Access Control](#)
- [OWASP Development Guide: Chapter on Authorization](#)

External

- [CWE-285: Improper Authorization](#)

API6:2019 Mass Assignment



Is the API Vulnerable?

Objects in modern applications might contain many properties. Some of these properties should be updated directly by the client (e.g., `user.first_name` or `user.address`) and some of them should not (e.g., `user.is_vip` flag).

An API endpoint is vulnerable if it automatically converts client parameters into internal object properties, without considering the sensitivity and the exposure level of these properties. This could allow an attacker to update object properties that they should not have access to.

Examples for sensitive properties:

- **Permission-related properties:** `user.is_admin`, `user.is_vip` should only be set by admins.
- **Process-dependent properties:** `user.cash` should only be set internally after payment verification.
- **Internal properties:** `article.created_time` should only be set internally by the application.

Example Attack Scenarios

Scenario #1

A ride sharing application provides a user the option to edit basic information for their profile. During this process, an API call is sent to `PUT /api/v1/users/me` with the following legitimate JSON object:

```
{"user_name": "inons", "age": 24}
```

The request `GET /api/v1/users/me` includes an additional `credit_balance` property:

```
{"user_name": "inons", "age": 24, "credit_balance": 10}.
```

The attacker replays the first request with the following payload:

```
{"user_name": "attacker", "age": 60, "credit_balance": 99999}
```

Since the endpoint is vulnerable to mass assignment, the attacker receives credits without paying.

Scenario #2

A video sharing portal allows users to upload content and download content in different formats. An attacker who explores the API found that the endpoint `GET /api/v1/videos/{video_id}/meta_data` returns a JSON object with the video's properties. One of the properties is `"mp4_conversion_params": "-v codec h264"`, which indicates that the application uses a shell command to convert the video.

The attacker also found the endpoint `POST /api/v1/videos/new` is vulnerable to mass assignment and allows the client to set any property of the video object. The attacker sets a malicious value as follows: `"mp4_conversion_params": "-v codec h264 && format C:/"`. This value will cause a shell command injection once the attacker downloads the video as MP4.

How To Prevent

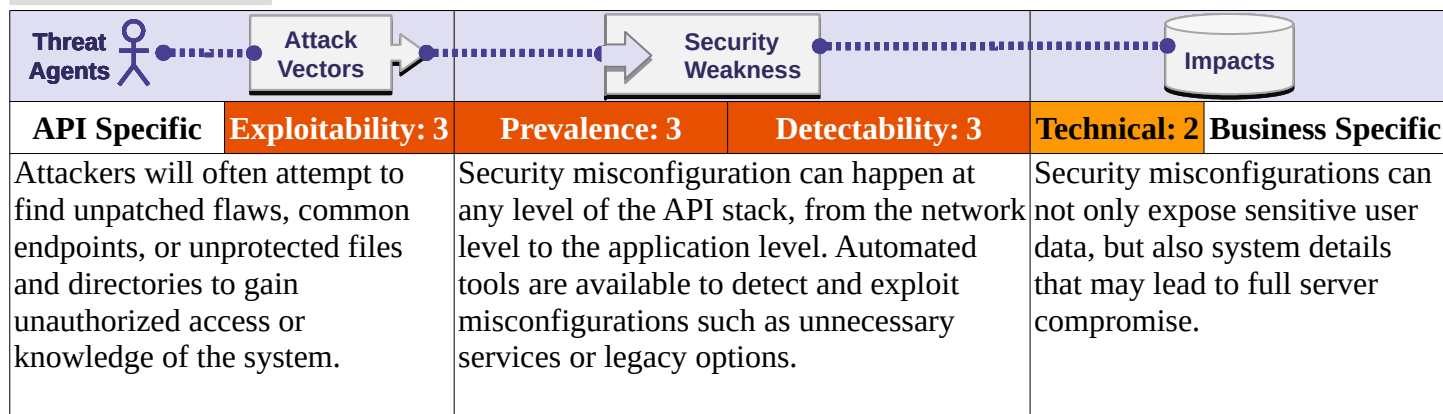
- If possible, avoid using functions that automatically bind a client's input into code variables or internal objects.
- Whitelist only the properties that should be updated by the client.
- Use built-in features to blacklist properties that should not be accessed by clients.
- If applicable, explicitly define and enforce schemas for the input data payloads.

References

External

- [CWE-915: Improperly Controlled Modification of Dynamically-Determined Object Attributes](#)

API7:2019 Security Misconfiguration



Is the API Vulnerable?

The API might be vulnerable if:

- Appropriate security hardening is missing across any part of the application stack, or if it has improperly configured permissions on cloud services.
- The latest security patches are missing, or the systems are out of date.
- Unnecessary features are enabled (e.g., HTTP verbs).
- Transport Layer Security (TLS) is missing.
- Security directives are not sent to clients (e.g., [Security Headers](#)).
- A Cross-Origin Resource Sharing (CORS) policy is missing or improperly set.
- Error messages include stack traces, or other sensitive information is exposed.

Example Attack Scenarios

Scenario #1

An attacker finds the `.bash_history` file under the root directory of the server, which contains commands used by the DevOps team to access the API:

```
$ curl -X GET 'https://api.server/endpoint/' -H 'authorization: Basic Zm9vOmJhcg=='
```

An attacker could also find new endpoints on the API that are used only by the DevOps team and are not documented.

Scenario #2

To target a specific service, an attacker uses a popular search engine to search for computers directly accessible from the Internet. The attacker found a host running a popular database management system, listening on the default port. The host was using the default configuration, which has authentication disabled by default, and the attacker gained access to millions of records with PII, personal preferences, and authentication data.

Scenario #3

Inspecting traffic of a mobile application an attacker finds out that not all HTTP traffic is performed on a secure protocol (e.g., TLS). The attacker finds this to be true, specifically for the download of profile images. As user interaction is binary, despite the fact that API traffic is performed on a secure protocol, the attacker finds a pattern on API responses size, which he uses to track user preferences over the rendered content (e.g., profile images).

How To Prevent

The API life cycle should include:

- A repeatable hardening process leading to fast and easy deployment of a properly locked down environment.
- A task to review and update configurations across the entire API stack. The review should include: orchestration files, API components, and cloud services (e.g., S3 bucket permissions).
- A secure communication channel for all API interactions access to static assets (e.g., images).
- An automated process to continuously assess the effectiveness of the configuration and settings in all environments.
- To prevent exception traces and other valuable information from being sent back to attackers, if applicable, define and enforce all API response payload schemas including error responses.

References

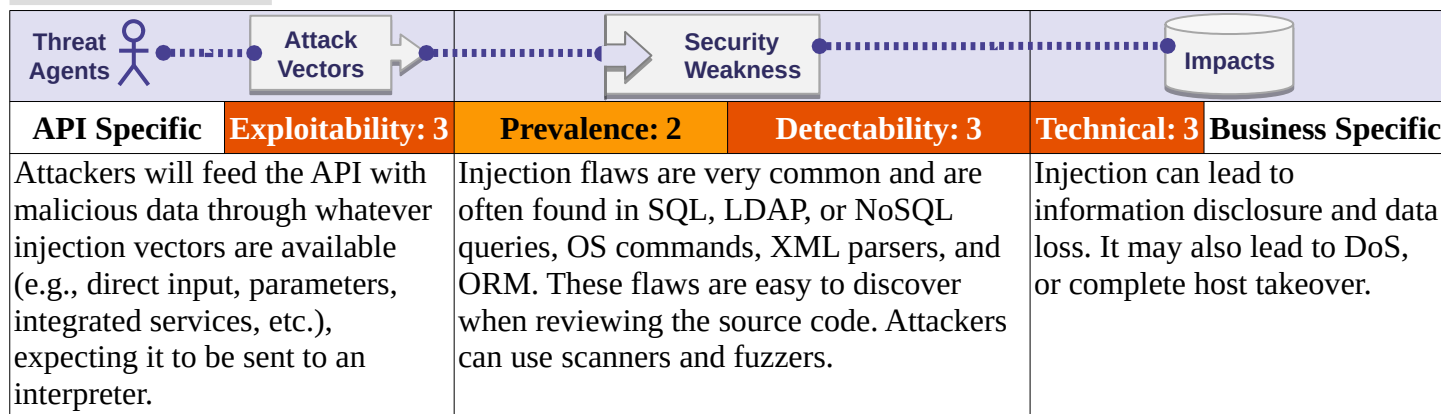
OWASP

- [OWASP Secure Headers Project](#)
- [OWASP Testing Guide: Configuration Management](#)
- [OWASP Testing Guide: Testing for Error Codes](#)

External

- [CWE-2: Environmental Security Flaws](#)
- [CWE-16: Configuration](#)
- [CWE-388: Error Handling](#)
- [Guide to General Server Security](#), NIST
- [Let's Encrypt: a free, automated, and open Certificate Authority](#)

API8:2019 Injection



Is the API Vulnerable?

The API is vulnerable to injection flaws if:

- Client-supplied data is not validated, filtered, or sanitized by the API.
- Client-supplied data is directly used or concatenated to SQL/NoSQL/LDAP queries, OS commands, XML parsers, and Object Relational Mapping (ORM)/Object Document Mapper (ODM).
- Data coming from external systems (e.g., integrated systems) is not validated, filtered, or sanitized by the API.

Example Attack Scenarios

Scenario #1

Inspecting the web browser network traffic, an attacker identifies the following API request responsible to start the recovery password workflow:

```
POST /api/accounts/recovery
{"username": "john@somehost.com"}
```

The attacker replays the request with a different payload

```
POST /api/account/recovery
{"username": "john@somehost.com";WAITFOR DELAY '0:0:5'--"}
```

This time, the response took ~5 seconds confirming the API is vulnerable to SQL injection. Exploiting this vulnerability, the attacker was able to gain unauthorized access to the system.

Scenario #2

Firmware of a parental control device provides the endpoint `/api/CONFIG/restore` which expects an `appId` to be sent as a multipart parameter. Using a decompiler, an attacker finds out that the `appId` is passed directly into a system call without any sanitization:

```
snprintf(cmd, 128, "%srestore_backup.sh /tmp/postfile.bin %s %d",
         "/mnt/shares/usr/bin/scripts/", appId, 66);
system(cmd);
```

The following command allows the attacker to shut down any device with the same vulnerable firmware:

```
$ curl -k "https://${deviceIP}:4567/api/CONFIG/restore" -F
'appid=$(/etc/pod/power_down.sh)'
```

Scenario #3

We have an application with basic CRUD functionality for operations with bookings. An attacker managed to identify that NoSQL injection might be possible through `bookingId` query string parameter in the delete booking request. This is how the request looks like: `DELETE /api/bookings?bookingId=678`.

The API server uses the following function to handle delete requests:

```
router.delete('/bookings', async function (req, res, next) {
  try {
    const deletedBooking = await Bookings.findOneAndRemove({'_id' : req.query.bookingId});
    res.status(200);
  } catch (err) {
    res.status(400).json({
      error: 'Unexpected error occurred while processing a request'
    });
  }
});
```

The attacker intercepted the request and changed `bookingId` query string parameter as shown below. In this case, the attacker managed to delete another user's booking:

```
DELETE /api/bookings?bookingId[$ne]=678
```

How To Prevent

Preventing injection requires keeping data separate from commands and queries.

- Perform data validation using a single, trustworthy, and actively maintained library.
- Validate, filter, and sanitize all client-provided data, or other data coming from integrated systems.
- Special characters should be escaped using the specific syntax for the target interpreter.
- Prefer a safe API that provides a parameterized interface.
- Always limit the number of returned records to prevent mass disclosure in case of injection.
- Validate incoming data using sufficient filters to only allow valid values for each input parameter.
- To prevent data leaks, define and enforce schemas for all API responses.
- Define data types and strict patterns for all string parameters.

References

OWASP

- [OWASP Injection Flaws](#)
- [SQL Injection](#)
- [NoSQL Injection Fun with Objects and Arrays](#)
- [Command Injection](#)

External

- [CWE-77: Command Injection](#)
- [CWE-89: SQL Injection](#)

API9:2019 Improper Assets Management

Threat Agents		Attack Vectors		Security Weakness		Impacts		
API Specific	Exploitability: 3	Prevalence: 3	Detectability: 2	Technical: 2	Business Specific			
Old API versions are usually unpatched and are an easy way to compromise systems without having to fight state-of-the-art security mechanisms, which might be in place to protect the most recent API versions.		Outdated documentation makes it more difficult to find and/or fix vulnerabilities. Lack of assets inventory and retire strategies leads to running unpatched systems, resulting in leakage of sensitive data. It's common to find unnecessarily exposed API hosts because of modern concepts like microservices, which make applications easy to deploy and independent (e.g., cloud computing, k8s).		Attackers may gain access to sensitive data, or even takeover the server through old, unpatched API versions connected to the same database.				

Is the API Vulnerable?

The API might be vulnerable if:

- The purpose of an API host is unclear, and there are no explicit answers to the following questions:
 - Which environment is the API running in (e.g., production, staging, test, development)?
 - Who should have network access to the API (e.g., public, internal, partners)?
 - Which API version is running?
 - What data is gathered and processed by the API (e.g., PII)?
 - What's the data flow?
- There is no documentation, or the existing documentation is not updated.
- There is no retirement plan for each API version.
- Hosts inventory is missing or outdated.
- Integrated services inventory, either first- or third-party, is missing or outdated.
- Old or previous API versions are running unpatched.

Example Attack Scenarios

Scenario #1

After redesigning their applications, a local search service left an old API version (`api.someservice.com/v1`) running, unprotected and with access to the user database. While targeting one of the latest released applications, an attacker found the API address (`api.someservice.com/v2`). Replacing `v2` with `v1` in the URL gave the attacker access to the old, unprotected API, exposing the personal identifiable information (PII) of over 100 Million users.

Scenario #2

A social network implemented a rate-limiting mechanism that blocks attackers from using brute-force to guess reset password tokens. This mechanism wasn't implemented as part of the API code itself, but in a separate component between the client and the official API (`www.socialnetwork.com`). A researcher found a beta API host (`www.mbasic.beta.socialnetwork.com`) that runs the same API, including the reset password mechanism, but the rate limiting mechanism was not in place. The researcher was able to reset the password of any user by using a simple brute-force to guess the 6 digits token.

How To Prevent

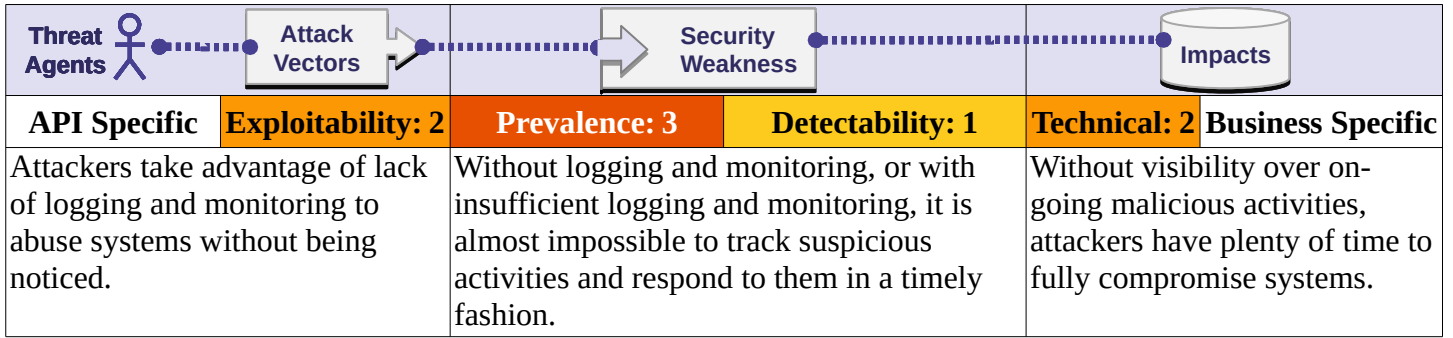
- Inventory all API hosts and document important aspects of each one of them, focusing on the API environment (e.g., production, staging, test, development), who should have network access to the host (e.g., public, internal, partners) and the API version.
- Inventory integrated services and document important aspects such as their role in the system, what data is exchanged (data flow), and its sensitivity.
- Document all aspects of your API such as authentication, errors, redirects, rate limiting, cross-origin resource sharing (CORS) policy and endpoints, including their parameters, requests, and responses.
- Generate documentation automatically by adopting open standards. Include the documentation build in your CI/CD pipeline.
- Make API documentation available to those authorized to use the API.
- Use external protection measures such as API security firewalls for all exposed versions of your APIs, not just for the current production version.
- Avoid using production data with non-production API deployments. If this is unavoidable, these endpoints should get the same security treatment as the production ones.
- When newer versions of APIs include security improvements, perform risk analysis to make the decision of the mitigation actions required for the older version: for example, whether it is possible to backport the improvements without breaking API compatibility or you need to take the older version out quickly and force all clients to move to the latest version.

References

External

- [CWE-1059: Incomplete Documentation](#)
- [OpenAPI Initiative](#)

API10:2019 Insufficient Logging & Monitoring



Is the API Vulnerable?

The API is vulnerable if:

- It does not produce any logs, the logging level is not set correctly, or log messages do not include enough detail.
- Log integrity is not guaranteed (e.g., [Log Injection](#)).
- Logs are not continuously monitored.
- API infrastructure is not continuously monitored.

Example Attack Scenarios

Scenario #1

Access keys of an administrative API were leaked on a public repository. The repository owner was notified by email about the potential leak, but took more than 48 hours to act upon the incident, and access keys exposure may have allowed access to sensitive data. Due to insufficient logging, the company is not able to assess what data was accessed by malicious actors.

Scenario #2

A video-sharing platform was hit by a “large-scale” credential stuffing attack. Despite failed logins being logged, no alerts were triggered during the timespan of the attack. As a reaction to user complaints, API logs were analyzed and the attack was detected. The company had to make a public announcement asking users to reset their passwords, and report the incident to regulatory authorities.

How To Prevent

- Log all failed authentication attempts, denied access, and input validation errors.
- Logs should be written using a format suited to be consumed by a log management solution, and should include enough detail to identify the malicious actor.
- Logs should be handled as sensitive data, and their integrity should be guaranteed at rest and transit.
- Configure a monitoring system to continuously monitor the infrastructure, network, and the API functioning.
- Use a Security Information and Event Management (SIEM) system to aggregate and manage logs from all components of the API stack and hosts.
- Configure custom dashboards and alerts, enabling suspicious activities to be detected and responded to earlier.

References

OWASP

- [OWASP Logging Cheat Sheet](#)
- [OWASP Proactive Controls: Implement Logging and Intrusion Detection](#)
- [OWASP Application Security Verification Standard: V7: Error Handling and Logging Verification Requirements](#)

External

- [CWE-223: Omission of Security-relevant Information](#)
- [CWE-778: Insufficient Logging](#)

The task to create and maintain secure software, or fixing existing ones, can be difficult. APIs are no different.

We believe that education and awareness are key factors to write secure software. Everything else required to accomplish the goal, depends on **establishing and using repeatable security processes and standard security controls**.

OWASP has numerous free and open resources to address security since the very beginning of the project. Please visit the [OWASP Projects page](#) for a comprehensive list of available projects.

<p>Education</p>	<p>You can start reading OWASP Education Project materials according to your profession and interest. For hands-on learning, we added crAPI - Completely Ridiculous API on our roadmap. Meanwhile, you can practice WebAppSec using the OWASP DevSlop Pixi Module, a vulnerable WebApp and API service intent to teach users how to test modern web applications and API's for security issues, and how to write more secure API's in the future. You can also attend OWASP AppSec Conference training sessions, or join your local chapter.</p>
<p>Security Requirements</p>	<p>Security should be part of every project from the beginning. When doing requirements elicitation, it is important to define what "secure" means for that project. OWASP recommends you use the OWASP Application Security Verification Standard (ASVS) as a guide for setting the security requirements. If you're outsourcing, consider the OWASP Secure Software Contract Annex, which should be adapted according to local law and regulations.</p>
<p>Security Architecture</p>	<p>Security should remain a concern during all the project stages. The OWASP Prevention Cheat Sheets are a good starting point for guidance on how to design security in during the architecture phase. Among many others, you'll find the REST Security Cheat Sheet and the REST Assessment Cheat Sheet.</p>
<p>Standard Security Controls</p>	<p>Adopting Standard Security Controls reduces the risk of introducing security weaknesses while writing your own logic. Despite the fact that many modern frameworks now come with built-in standard effective controls, OWASP Proactive Controls gives you a good overview of what security controls you should look to include in your project. OWASP also provides some libraries and tools you may find valuable, such as validation controls.</p>
<p>Secure Software Development Life Cycle</p>	<p>ou can use the OWASP Software Assurance Maturity Model (SAMM) to improve the process when building APIs. Several other OWASP projects are available to help you during the different API development phase,s e.g., the OWASP Code Review Project.</p>

Due to their importance in modern application architectures, building secure APIs is crucial. Security cannot be neglected, and it should be part of the whole development life cycle. Scanning and penetration testing yearly are no longer enough.

DevSecOps should join the development effort, facilitating continuous security testing across the entire software development life cycle. Their goal is to enhance the development pipeline with security automation, and without impacting the speed of development.

In case of doubt, stay informed, and review, the [DevSecOps Manifesto](#) often.

Understand the Threat Model	Testing priorities come from a threat model. If you don't have one, consider using OWASP Application Security Verification Standard (ASVS) , and the OWASP Testing Guide as an input. Involving the development team may help to make them more security-aware.
Understand the SDLC	Join the development team to better understand the Software Development Life Cycle. Your contribution on continuous security testing should be compatible with people, processes, and tools. Everyone should agree with the process, so that there's no unnecessary friction or resistance.
Testing Strategies	As your work should not impact the development speed, you should wisely choose the best (simple, fastest, most accurate) technique to verify the security requirements. The OWASP Security Knowledge Framework and OWASP Application Security Verification Standard can be great sources of functional and nonfunctional security requirements. There are other great sources for projects and tools similar to the one offered by the DevSecOps community .
Achieving Coverage and Accuracy	You're the bridge between developers and operations teams. To achieve coverage, not only should you focus on the functionality, but also the orchestration. Work close to both development and operations teams from the beginning so you can optimize your time and effort. You should aim for a state where the essential security is verified continuously.
Clearly Communicate Findings	Contribute value with less or no friction. Deliver findings in a timely fashion, within the tools development teams are using (not PDF files). Join the development team to address the findings. Take the opportunity to educate them, clearly describing the weakness and how it can be abused, including an attack scenario to make it real.

Overview

Since the AppSec industry has not been specifically focused on the most recent applications architectures, in which APIs play an important role, compiling a list of the ten most critical API security risks, based on a public call for data, would have been a hard task. Despite there being no public data call, the resulting Top 10 list is still based on publicly available data, security experts contributions, and open discussion with the security community.

Methodology and Data

In the first phase, publicly available data about APIs security incidents were collected, reviewed, and categorized by a group of security experts. Such data was collected from bug bounty platforms and vulnerability databases, within a one-year-old time frame. It was used for statistical purposes.

In the next phase, security practitioners with penetration testing experience were asked to compile their own Top 10 list.

The [OWASP Risk Rating Methodology](#) was used to perform the Risk Analysis. The scores were discussed and reviewed between the security practitioners. For considerations on this matters, please refer to the [API Security Risks](#) section.

The first draft of the OWASP API Security Top 10 2019 resulted from a consensus between statistical results from phase one, and the security practitioners' lists. This draft was then submitted for appreciation and review by another group of security practitioners, with relevant experience in the API security fields.

The OWASP API Security Top 10 2019 was first presented in the OWASP Global AppSec Tel Aviv event (May 2019). Since then, it has been available on GitHub for public discussion and contributions.

The list of contributors is available in the [Acknowledgments](#) section.

Acknowledgments to Contributors

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