Open Retailing API Implementation Guide: Security

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V1.1

Document Summary

This document describes the Open Retailing (fuel retailing and convenience store) API implementation guidelines for security.

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1 Introduction

This document is part of a set of standards and guides for implementing Open Retailing JSON messages using the RESTful web services. The rationale for using HTTPS and RESTful web services is found in a companion document, Open Retailing API Implemention Guide: Transport Alternatives, which describes the possible alternative transport mechanisms in a priority sequence. This document describes the security aspects of those transport technologies. Security is in a separate document since it is more frequently updated alongside industry best practice. This guide helps ensure that implementations interoperate with minimal development and configuration by reducing choices implementers have to make.

Please note in this document the key words, “MUST”, “MUST NOT”, “REQUIRED”, “SHALL”, “SHALL NOT”, “SHOULD”, “SHOULD NOT”, “RECOMMENDED”, “MAY” and “OPTIONAL” in this document are to be interpreted as described in the IETF RFC2119 to indicate requirement levels. As defined in the IETF RFC2119, these words are shown in capital letters.

All implementations, irrespective of data sensitivity, **MUST** be HTTPS. HTTP **MAY** be used during development and initial testing stages. This document supercedes IFSF Standard Forecourt Protocol Part II-3 IFSF Communications over HTTP Rest for API implementations.

1.1 Audience

The intended audiences of this document include, non-exhaustively:

- Architects and developers designing, developing, or documenting RESTful Web Services; and
- Standards architects and analysts developing specifications that make use of Open Retailing REST based APIs.

2 Security Considerations

Note: Enabling the use of proxies and firewalls is beyond the scope of this document, other than configurations requiring headers or schemes that are declared invalid in this document.

2.1 Network Security

2.1.1 Use of TLS

NIST provides extensive guidelines for the selection, configuration, and use of Transport Layer Security (TLS) Implementations. While key parts are extracted below, the full set

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of guidelines, Special Publication 800-52, should be referenced when developing implementations.

TLS **MUST** be supported by all parties, although it **MAY** be disabled during testing. Whenever TLS is active, the following rules **MUST** be observed:

- TLS version: servers and clients **MUST** support TLS 1.3 or at least TLS 1.2;
- SSL 2.0, SSL 3.0, TLS 1.0 and TLS 1.1 **MUST NOT** be used and are forbidden;;
- Key exchange: servers and clients **MUST** support DHE-RSA (forward secrecy), which is part of both TLS 1.2 and TLS 1.3 draft;
- Block Ciphers: servers and clients **MUST** support AES-256 CBC. DES, 3DES, AES-128 and AES192 **MUST NOT** be used and are forbidden;
- Data integrity: servers and clients **MUST** support HMAC-SHA256/384. HMAC-MD5 and HMAC-SHA1 **MUST NOT** be used and are forbidden;
- Vendors are allowed to support other TLS, key exchange, block ciphers and data integrity algorithms. These are **OPTIONAL,** but may result in a non interoperable implementation;
- Certificates signed using MD5 or SHA1 **MUST NOT** be trusted. All vendors **MUST** support certificates signed using SHA-256. Self-signed certificates are allowed; and
- Vendors **MUST** provide mechanisms for authorized users and technicians to disable security algorithms in order to keep up with security industry recommendations. As reference for vulnerability publications, please refer to the NIST national vulnerability database and/or the Mitre common vulnerabilities and exposures.

2.1.2 Certificate Management

Each software supplier **SHOULD** provide a documented means of loading certificates in order to connect to other applications. In addition, it SHOULD provide a certificate for connecting applications. The following functions must be supported:

- Adding a root or intermediate certificate to connect to the certificate store;
- Revoking a certificate; and
- Connecting to one or more external certificate providers. This will give the purchaser of the system the possibility to manage certificates centrally.

Implementation details for these functions are the responsibility of each software supplier but they **SHOULD** be made available for review during any certification process..

The client systems **MUST** support both Online Certificate Status Protocol (OCSP) and Certificate Revocation List (CRL) for online certificate verification. In case of the CRL

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repository or the OCSP server not being available, the implementer **SHOULD** be capable of determining if a soft fail (assume the certificate has not being revoked) is allowed or not.

OCSP and/or a hard fail must be enforced if:

- There is a legal obligation to enforce the certificate and certificate chain; or
- The CRL grows indiscriminately or there is no one to maintain it.

At the time of writing, CRLSet as proposed by Google for CRL distribution and offline certificate verification is still sufficiently challenging not to be included in this standard.

2.1.3 Threat Model

The OWASP (Open Web Application Security Project) provides a good outline for a viable threat model:

- **Assessment Scope** - The first step is always to understand what's on the line. Identifying tangible assets, like databases of information or sensitive files is usually easy. Understanding the capabilities provided by the application and valuing them is more difficult. Less concrete things, such as reputation and goodwill are the most difficult to measure, but are often the most critical.
- **Identify Threat Agents and possible Attacks** - A key part of the threat model is a characterization of the different groups of people who might be able to attack your application. These groups should include insiders and outsiders, performing both inadvertent mistakes and malicious attacks.
- **Understand existing Countermeasures** - The model must include the existing countermeasures
- **Identify exploitable Vulnerabilities** - Once you have an understanding of the security in the application, you can then analyze for new vulnerabilities. The search is for vulnerabilities that connect the possible attacks you've identified to the negative consequences you've identified.
- **Prioritized identified risks** - Prioritization is everything in threat modeling, as there are always lots of risks that simply don't rate any attention. For each threat, you estimate a number of likelihood and impact factors to determine an overall risk or severity level.
- **Identify Countermeasures to reduce threat** - The last step is to identify countermeasures to reduce the risk to acceptable levels.

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2.2 Application Authentication and Authorization

Authentication and authorization methods **SHOULD** be supported for every Open Retailing compliant API. Options are:

- Username and Password;
- API keys; or
- OAuth 2.0.

The **RECOMMENDED** choice is OAUTH2.0 whenever possible. The implementing parties **MUST NOT** disable all authentication methods, hence providing access with no authentication. This is true even when the implementer deems the infrastructure is already secure, or if access authentication and authorization is delegated to an external application.

Any Open Retailing compliant API **MAY** implement OAuth 2.0 for delegation of authentication functions, which allows for central management of API access. . Although not mandatory, applications connecting to a REST API are **RECOMMENDED** to support API keys authentication over OAuth 2.0 architecture, as APIs security can be enhanced to support OAuth security through third party application packages.

Note: Use of HTTP digest access authentication is not recommended because TLS provides higher levels of security, as well as better encryption keys management processes.

To provide a higher level of security and implementing advanced security features while keeping security implementation and management processes unified for all implemented APIs, the implementer MAY deploy a central security management application to decouple authentication from APIs.

There are both open source and enterprise grade available API manager software applications that provide security services, including but not limited to:

- OAuth security;
- Token based security;
- End to end encryption with TLS;
- Rate limiting to control traffic;
- Centralized administration;
- Monitoring tools; and
- Revocation policies.

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An API manager software application adds security to an unsecured API by exposing new secured endpoints to API clients and, once properly authorized, forwarding the request to the unsecured API, as depicted in the figure below:

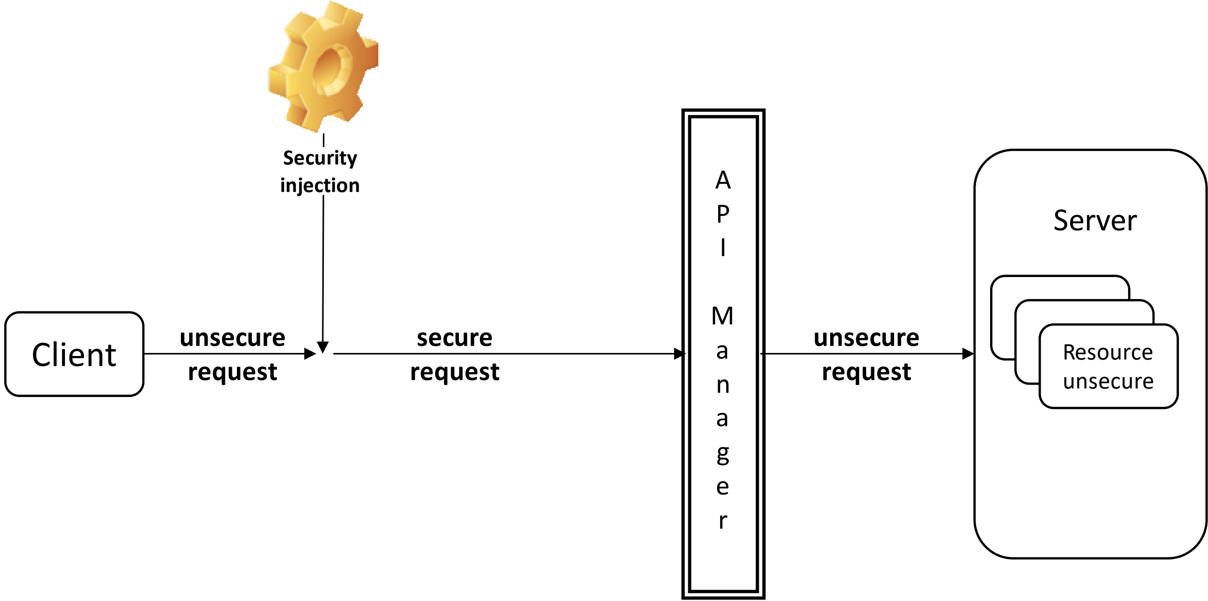

Figure 1: Using API Managers to Secure Resources

Note: Although an API manager can add security to an unsecured API, injection of security into the client will still be required.

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Implementing advanced security features *within APIs* is not recommended because:

- Software development complexity;
  - Cost of development
  - Time of implementation
  - Need of specialized development professionals
  - High testing complexity
  - High certification complexity
- Cost of Support over a large variety of systems; and
- Permanent need to update security to keep up to date throughout time.
  Security algorithms are permanently deprecated due to detected vulnerabilities (e.g., DES)

In other words, don't create security infrastructure where advance infrastructure already exists.

2.2.1 Using Username and Password to Authenticate Users

To request access using a username and password combination, the client application must include in the header a string containing username and password separated by a colon encoded in base64. Note: Base64 encoding will not provide any level of encryption; encryption can be achieved by using TLS 1.2.

Submitted request:

```
POST /fdc/v2/sites
Host: api.openretailing.org
Authorization: Basic SUZTRkNsaWVudDpwbGVhc2VHaXZlTWVBY2Nlc3M=
Content-Type: charset=UTF-8
Body Payload
```

2.2.2 Using API Keys to Authenticate Access

Whenever OAuth2 is not available, (System running at the sites or using proprietary authorization mechanism), implementers of OpenRetailing.org APIs can use an API key.

API Key is a secret shared across multiple endpoints. Ideally, each endpoint component will carry its own API Key, which MUST only be known by trusted systems.

To make the secret harder to guess, do not use common phrases or readable text. Use a random alphanumeric value no shorter than 32 characters, make it as long as possible up to 1024 characters.

Note that without TLS, API Keys provide no additional security.

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To use API Keys, the endpoint initiating the communication (client), must include the header x-api-key. The x-api-key value must be a sequence of random characters in the range A-Z, a-z, and 0-9.

The OpenRetailing APIs using the data dictionary "statusReturn" can take advantage of the field "apiKey" to rotate the key. Endpoints capable of monitoring for anomalies, (Request from an unknown IP address, spoofing or replays), can use that field to rotate the API key. When the client receives a new API Key, it must update its secure storage with the new information. Once the API Key is updated, subsequent requests should contain the new API Key.

If the client attempt further requests with an staled API Key, the receiving end should reply with a “Failure” response.

2.2.3 Using OAuth2.0 to Authenticate API Keys

API Keys over Oauth2.0 can be used to authenticate communications between devices. OAuth2.0 is the Open Retailing **RECOMMENDED** authentication method.

The API key performs application only authentication. Implementers of API key authentication should keep in mind the following:

- Tokens are passwords: The consumer key & secret, bearer token credentials, and the bearer token itself grant access to make requests on behalf of an application. These values **SHOULD** be considered as sensitive as passwords and **MUST NOT** be shared or distributed to untrusted parties. The implementer **MUST** define proper ways to store and distribute these tokens. TLS is mandatory during token negotiation: This authentication method is only secure if TLS is used. Therefore, all requests (to both obtain and use the tokens) **MUST** use HTTPS endpoints.
- No user context: When issuing requests using application-only auth, there is no concept of a “current user.”
- The application-only authentication flow follows these steps:
    1. An application encodes its consumer key and secret into a specially encoded set of credentials.
    2. An application makes a request to the POST oauth2 / token endpoint to exchange these credentials for a bearer token.
    3. When accessing the REST API, the application uses the bearer token to authenticate.
    4. The server manages access to the corresponding entity and verb depending on the token received.

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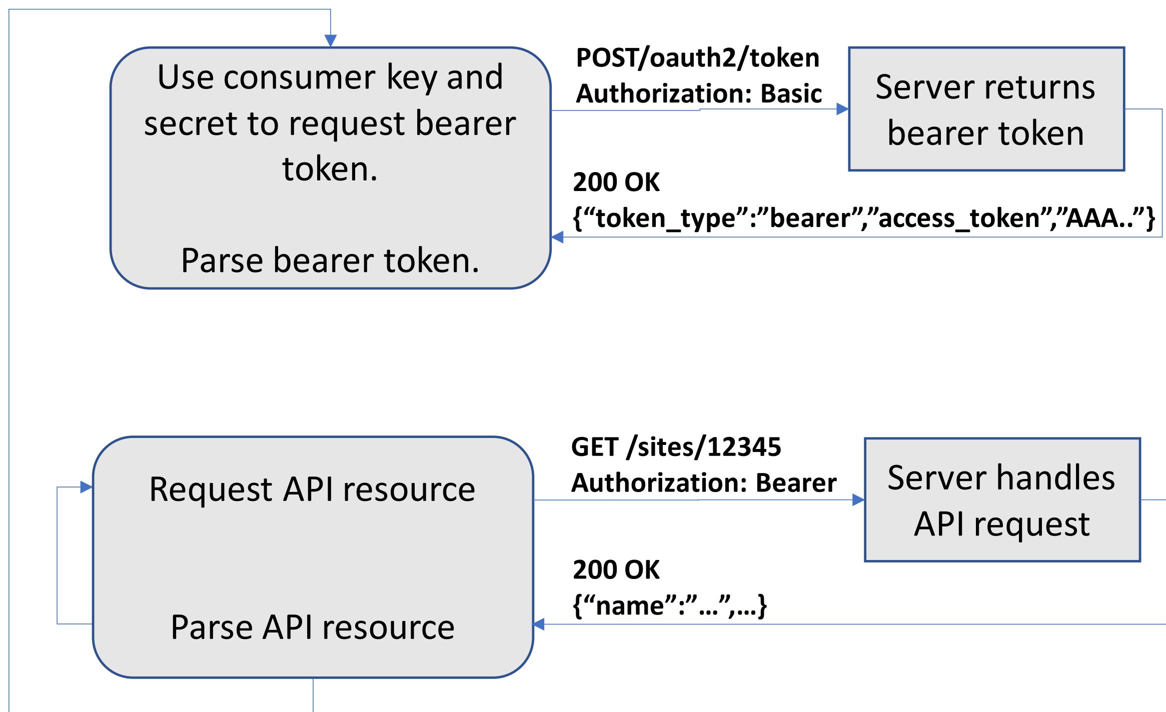

Figure 2: Application-only authentication flow

2.2.3.1 Encoding Consumer Key and Secret

The steps to encode an application's consumer key and secret into a set of credentials to obtain a bearer token are:

1. URL encode (refer to IETF RFC 1738) the consumer key and the consumer secret. Note that at the time of writing, this will not actually change the consumer key and secret, but this step should still be performed in case the format of those values changes in the future.
2. Create the bearer token credentials by concatenating the encoded consumer key, a colon character ":", and the encoded consumer secret into a single string.
3. Base64 encode the string from the previous step.

Below are example values showing the result of each step of this algorithm.

RFC 1738 encoded consumer key	xvz1evFS4wEEPTGEFPHBog
RFC 1738 encoded consumer secret	L8qq9PZyRg6ieKGEKhZolGCovJWLw8iEJ88DRdyOg
Bearer token credentials	xvz1evFS4wEEPTGEFPHBog:L8qq9PZyRg6ieKGEKhZolGCovJWL w8iEJ88DRdyOg
Base64 encoded bearer token credentials	eHZ6MWV2RlModoVFUFRHRUZQSEJvZzpMOHFxOVBaeVJnNmllSodFS 2hab2xHQzB2SldMdzhpRUo4OERSZHlPZw==

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2.2.3.2 Obtain a Bearer Token

The value calculated in previous step **MUST** be exchanged for a bearer token by issuing a request to POST oauth2 / token:

- The request **MUST** be an HTTPS POST request.
- The request **MUST** include an `Authorization` header with the value of `Basic` along with the base64 encoded bearer token credential.
- The request **MUST** include a `Content-Type` header with the value of `application/x-www-form-urlencoded;charset=UTF-8`.
- The body of the request **MUST** be `grant_type=client_credentials`.

Example request (Authorization header has been wrapped):

```
POST / fdc/v2/oauth2/token HTTPS/1.1
Host: api.openretailing.org
Authorization: Basic eHZ6MWV2RlM0d0VFUFRHRUZQSEJvZzpMOHFxOVBaeVJn
NmllS0dFS2hab2xHQzB2SldMdzhpRUo4OERSZHlPZw==
Content-Type: application/x-www-form-urlencoded;charset=UTF-8
Content-Length: 29
grant_type=client_credentials
```

If the request format is correct, the server will respond with a JSON-encoded payload:

Example Response:

```
HTTPS/1.1 200 OK
Status: 200 OK
Content-Type: application/json; charset=utf-8
Content-Length: 140

{"token_type":"bearer","access_token":"AAAAAAAAAAAAAAAAAAAAAAAAAA
AAAAAAAAAAAA%2FAAAAAAAAAAAAAAAAAAAAA%3DAAAAAAAAAAAAAAAAAAAAAAAAAAA
AAAAAAAAAAAAAAA"}
```

Applications should verify that the value associated with the `token_type` key of the returned object is `bearer`. The value associated with the `access_token` key is the bearer token itself.

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2.2.3.3 Authenticate API Requests with a Bearer Token

The bearer token **MAY** be used to issue requests to API endpoints that support application-only authentication. To use the bearer token, construct a normal HTTPS request and include an `Authorization` header with the value of `Bearer` along with the base64 bearer token value obtained earlier. Signing is not required.

Example request (Authorization header has been wrapped):

```
GET /fdc/v2/sites/country=UK?count=100&limit=10 HTTP/1.1
Host: api. openretailing.org
Authorization: Bearer
AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA%2FAAAAAAAAA
AAAAAAAAAAAAA%3DAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA
Accept-Encoding: gzip
```


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3 Other Considerations

3.1 Parameters Passed in the URL (Path)

In some scenarios, when designing RESTFul APIs, it makes sense to include parameters in the path. Typically, the design will follow the pattern of "resource/resource identifier." For instance, the URI "`https://resource/{resourceID}`" represents an action on the resource with the identification "resourceID". Below are a few more examples:

`https://item/{itemID}`; and

`https://product/{productID}`.

Passing resource identifier in the path is a common industry practice. The "Open Retailing Design Rules for APIs" allows for it; however, additional options are available.

An API designer may opt to use HTTP headers or, in some cases, the requestBody to pass data if the designer prefers not to use the resource identifier.

Note that for the HTTP GET or DELETE methods, the only additional option is to use HTTP headers, because no "request body" semantic is defined for HTTP GET or DELETE verbs, and most web servers will silently drop the content of the request "body."

If the API relies on POST or PUT, then either HTTP headers or the HTTP request body may be used to align with standard practice.

If the API collection uses all HTTP verbs to perform its functions, it may make more sense to use the HTTP header. The reason is so the API does not have a mix of the same parameters passed in the request body and the header. Keeping the API collection consistent may simplify the understanding of the API.

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4 Security Process for Openretailing

4.1 Initial Design

The security process requires a threat model be created for the API group being developed both when the API is designed, and when the API is implemented. These two steps are most often done by different groups. The design stage is within Conexxus, and is part of the reviewed documentation; the implementation stage is completed by a Conexxus member (or their assigns) and may vary from the design recommendations, where any departure from the design recommendations must be explained.

In order to accommodate the two stages, Conexxus provides the following templates:

1. Threat Model (Designer)
2. Threat Model (Implementer)

The committee completing the initial design of the API MUST provide a threat model as defined in the designer template, including a diagram created with the "Microsoft Threat Modeling Tool." In addition to the threat model diagram, the template provides a series of lists of questions that must be answered.

Note: In addition to a design threat model, any security topics relevant to implementation must be enumerated in the "Security Considerations" section of the Implementation Guide.

4.2 Initial Implementation

In most cases, an implementer will follow all of the recommendations in the "Threat Model (Designer)" document. In any case, the implementer SHOULD complete a "Threat Model (Implementer)" document, highlighting any departures from the design recommendations.

Note: though not called out as a requirement, having the implementer submit their implementation threat model back to the designing committee could help the committee to refine the design requirements.

4.3 Subsequent Designs and Implementations

The "Open Retailing API Design Rules for JSON" spell out the system of version numbering (based on "Subversion" numbering). While a minor version is backwardly compatible, that doesn't necessarily mean that the security requirements are the same. Therefore, an incremental version requires a review of the threat model, and a publication of either the original designer model, or a new threat model.

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5 Appendices

A. References

A.1 Normative References

CA/Browser Forum: Baseline Requirements Certificate Policy for the Issuance and Management of Publicly-Trusted Certificates:
https://cabforum.org/wp-content/uploads/Baseline_Requirements_V1_3_1.pdf

Open Retailing API Implementation Guide - Transport Alternatives:
https://www.conexxus.org OR https://www.ifsf.org

IETF RFC 1738 Uniform Resource Locators (URL):
https://www.ietf.org/rfc/rfc1738.txt

IETF RFC 2119 Key words for use in RFCs to Indicate Requirement Levels:
https://www.ietf.org/rfc/rfc2119.txt

IETF RFC 4169 HTTP Digest Authentication Using Authentication and Key Agreement (AKA) Version-2:
https://www.ietf.org/rfc/rfc4169.txt

IETF RFC 7234 HTTP/1.1: Caching:
https://www.ietf.org/rfc/rfc7234.txt

Mitre: Common Vulnerabilities and Exposures:
https://cve.mitre.org/

NIST National vulnerability database:
https://nvd.nist.gov/

NIST Special Publication 800-154, Guide to Data-Centric System Threat Modeling:
https://csrc.nist.gov/publications/detail/sp/800-154/draft

NIST Special Publication 800-52, Guidelines for the Selection, Configuration, and Use of TLS Implementations:
https://csrc.nist.gov/publications/detail/sp/800-52/rev-1/final

NSA Guidelines for Implementation of REST:
https://apps.nsa.gov/iaarchive/library/ia-guidance/security-configuration/applications/guidelines-for-implementation-of-rest.cfm

OWASP (Open Web Application Security Project):
https://www.owasp.org/index.php/Category:Threat_Modeling

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A.2 Non-Normative References

None

B. Glossary

Term	Definition
API	**A**pplication **P**rogramming **I**nterface. An API is a set of routines, protocols, and tools for building software applications
Open Retailing	Open Retailing means both Service (Gas) Station and Convenience Store.
IFSF	International Forecourt Standards Forum
Internet	The name given to the interconnection of many isolated networks into a virtual single network.
IETF	The Internet Engineering Task Force
JSON	**J**ava**S**cript **O**bject **N**otation; is an open standard format that uses human-readable text to transmit data objects consisting of properties (name-value pairs), objects (sets of properties, other objects, and arrays), and arrays (ordered collections of data, or objects. JSON is in a format which is both human-readable and machine-readable.
OAS	OAS (OpenAPI Specification) is a specification for machine-readable interface files for describing, producing, consuming, and visualizing RESTful web services. The current version of OAS (as of the date of this document) is 3.0.
Port	A logical address of a service/protocol that is available on a particular device.
REST	**RE**presentational **S**tate **T**ransfer) is an architectural style, and an approach to communications that is often used in the development of Web Services.
Service	A process that accepts connections from other processes, typically called client processes, either on the same device or a remote device.
TLS	**T**ransport **L**ayer **S**ecurity

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