TAXII 2.1 Interoperability Test Document Version 1.0

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- *STIX Version 2.1*. Edited by Bret Jordan, Rich Piazza, and Trey Darley. Latest stage: https://docs.oasis-open.org/cti/stix/v2.1/stix-v2.1.html.
- *TAXII Version 2.1.* Edited by Bret Jordan and Drew Varner. Latest stage: https://docs.oasis-open.org/cti/taxii/v2.1/taxii-v2.1.html.
- *STIX 2.1 Interoperability Test Document Version 1.0.* Edited by John-Mark Gurney, Bret Jordan, Michael Rosa, Marlon Taylor, Rajesh Patil, Justin Stewart, and Kartikey Desai. https://docs.oasis-open.org/cti/stix-2.1-interop/v1.0/stix-2.1-interop-v1.0.html.

Abstract:

This is the Interoperability test document to supplement the Trusted Automated Exchange of Intelligence Information 2.1 OASIS Standard developed by the Cyber Threat Intelligence Technical Committee (CTI TC) of the Organization for the Advancement of Structured Information Systems (OASIS). This test document provides detailed requirements on how product implementers within the threat intelligence ecosystem may demonstrate TAXII 2.1 interoperability compliance. There are several personas detailed in section 1.3 of this document. These are: TAXII Client (TXC) and TAXII Server (TXS). This Interoperability test document defines tests of the following use cases: authentication and authorization, server discovery, GET API Root information, GET collections, GET a collection, GET object manifests, GET objects, GET an object, GET object versions, add objects, GET status, DELETE an object, filter results, pagination, and custom properties. For each of these use cases the document defines what the TXC and TXS need to support to satisfy each test case.

Status:

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Key words:

The key words "**MUST**", "**MUST NOT**", "**REQUIRED**", "**SHALL**", "**SHALL NOT**", "**SHOULD**", "**SHOULD NOT**", "**RECOMMENDED**", "**NOT RECOMMENDED**", "**MAY**", and "**OPTIONAL**" in this document are to be interpreted as described in BCP 14 [RFC2119] [RFC8174] when, and only when, they appear in all capitals, as shown here.

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Table of Contents

1 Introduction

This document provides details of the Trusted Automated Exchange of Intelligence Information (TAXII) 2.1 Interoperability Test Document. It lists a set of use cases that a persona (see section 1.3) **MUST** follow as they develop minimally viable TAXII-compliant tools and services. To claim TAXII interoperability compliance, persona tools/services **MUST** adhere to expected behaviors and outcomes as detailed in the use cases.

The OASIS Cyber Threat Intelligence Technical Committee (CTI TC) recommends users of this test document become familiar with the TAXII 2.1 OASIS Standard https://docs.oasis-open.org/cti/taxii/v2.1/os/taxii-v2.1-os.html (as given in the Related Work section above) prior to implementing the use cases in this document. This is what this document is referring to when it mentions "TAXII 2.1 OASIS Standard".

NOTE: The TAXII 2.1 OASIS Standard contains normative references to other specifications with which an implementation **MAY** need to reference and meet in order to comply with these specifications. This document assumes that such requirements are also met.

1.1 Terminology

Client - A software instance that can connect to and utilize the services/resources of a server
Server - A software instance that enables and manages access to a resource or service
TAXII container resource - Either a TAXII Envelope, Manifest Resource, or Versions Resource

1.2 Overview

The approach that is being taken within the CTI TC is to rely primarily on well-defined, common use cases to drive the interoperability between products using TAXII 2.1. Section 3 of this document outlines these common use cases for organizations seeking to develop and demonstrate interoperability.

These use cases will enable personas (see section 1.3) of the cyber threat intelligence information sharing community to build and test information sharing systems that are compliant with TAXII 2.1 interoperability. Future revisions to the TAXII 2.1 OASIS Standard will be incorporated into a new version of this document.

1.3 Personas

For an organization to demonstrate TAXII 2.1 interoperability compliance, their software instances will adhere to persona behavior and prescribed content as detailed in the test cases.

For documenting interoperability compliance for each persona tested, refer to the checklist and test requirements in section 4 Persona Checklist of this document. The following system personas are used throughout this document.

- TAXII Client (`TXC`) - A software package that connects to a TAXII Server and supports the exchange of CTI.
- TAXII Server (`TXS`) - A software package that supports the exchange of CTI.

2 Use Case Details

This Test Document defines a set of interoperability requirements for each persona defined in section 1.3. All use cases require the use of a TAXII Server (TXS) in concert with the TAXII Client (TXC) persona components as shown below.

A software instance **MAY** implement multiple personas. Therefore, it is conceivable that a single software instance **MAY** support both the TXC and TXS personas. However, for the purposes of this test case document, each persona's required behavior is called out separately.

The following figure provides a simplified diagram to highlight the relationship between a TXC and a TXS. In some cyber threat intelligence sharing ecosystems, TAXII Servers can support multiple TAXII Clients and TAXII Clients can support multiple TAXII Servers.

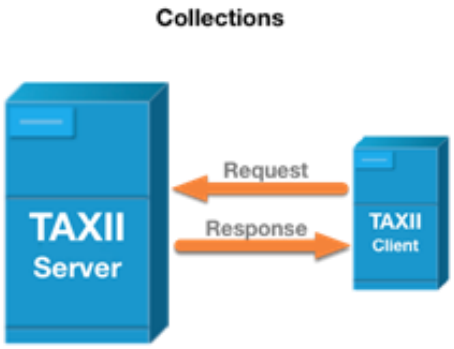

Figure 1. TAXII Client and TAXII Server Interactions

This document details the following use cases.

Table 1 - List of TAXII Interoperability Use Cases

	TAXII Client (TXC)	TAXII Server (TXS)
Authentication & Authorization	Required	Required
Certificate-based Authentication	Required	Optional
HTTP Basic Authentication	Required	Optional
Server Discovery	Required	Required
GET API Root Information	Required	Required
GET Collections	Required	Required

GET a Collection	Required	Required
GET Object Manifests	Required	Required
GET Objects	Required	Required
GET an Object	Required	Required
GET Object Versions	Required	Required
Add (POST) Objects	Required	Required
GET Status	Required	Required
GET All Status Properties	Required	Optional
DELETE an Object	Required	Required
Filter Results - TAXII 2.1 OASIS Standard	Optional	Optional
Filter Results - Additional Filters	Optional	Optional
Pagination	Required	Required
Custom Properties	Required	Required

2.1 Common Use Case Requirements

The following use case requirements apply to all tests in section 3.

2.1.1 Protocols

a. The HTTPS over IPv4 protocol **MUST** be used for all test cases.
b. There are no defined tests in this document that exclude IPv6 support.

2.1.2 Object Content

For the purposes of TAXII 2.1 Interoperability, all HTTP Accept and Content-Type headers will be TAXII version 2.1 media type "`application/taxii+json;version=2.1`". The TAXII Interoperability document will focus on using TAXII container resources (i.e., TAXII Envelope, Manifest Resource, and the Versions Resource).

In this document, TAXII Clients will use STIX 2.1 content and **MAY** conform to personas defined in section 1.2.1 of the STIX 2.1 Interoperability test document.

For the purposes of this TAXII Interoperability document, when a TXC sends objects to a TXS, the TXC **MUST** include all of the referenced objects within a single TAXII container resource. However, when a TXS is sending objects to a TXC, all of the objects **MAY** not necessarily be contained within a single TAXII container resource; see section 3.14 for more details.

2.1.3 Empty Lists

Section 2 of the TAXII 2.1 OASIS Standard, "Empty lists are prohibited in TAXII and **MUST NOT** be used as a substitute for omitting optional properties."

2.1.4 User-Agent Strings

A TXC **MUST** include its software name and version in the User-Agent HTTP header when transmitting a request to a TXS. See section 3.2 of the TAXII 2.1 OASIS Standard for more details.

A TXS **MUST NOT** reject a request that is missing the User-Agent header from a TAXII Client which conforms to section 8.4 of the TAXII 2.1 OASIS Standard, but does not conform to the requirements in 4.1 TAXII Client (TXC).

2.1.5 Custom Properties

A TXS or a TXC **MAY** encounter custom properties in the content it receives, and/or it **MAY** include custom properties in the content it sends. For more details on ensuring interoperability while handling custom properties, see section 3.15.

2.1.6 TLS Cipher Suites

A TXC **MUST NOT** use TLS 1.2 with any of the cipher suites that are listed in the cipher suite blacklist in Appendix A of [RFC7540].

2.1.7 Sorting

A TXS returning a Collections Endpoint response **MUST** sort Collection Resources in ascending order by **id**. See section 3.3 of the TAXII 2.1 OASIS Standard for more information about sorting.

2.2 Authentication and Authorization

The TAXII 2.1 OASIS Standard provides authentication and authorization schemes used by TXS and TXC. Please see section 1.6.9 and section 8 in the TAXII 2.1 OASIS Standard for further details.

TXS **MUST** implement support for at least one of the following authentication methods: HTTP Basic authentication (see section 8.2.2), certificate-based authentication (see section 8.3.1).

TXC **MUST** implement support for both HTTP Basic authentication (see section 8.5.1) and certificate-based authentication (see section 8.5.2).

3 Use Cases

The use cases in this section apply to TAXII Clients (TXC) that connect to a TAXII Server (TXS). For further details on which tests are required for interoperability, refer to section 4: Persona Checklist.

3.1 Authentication and Authorization

TAXII implements Authentication and Authorization as described in section 2.2. The first two tests below verify that the TXC and TXS personas handle authorization parameter errors; the third test verifies they handle certificate-based authentication.

3.1.1 Missing Authorization Parameter Test Case

This test verifies that the TXS will respond with the appropriate error to client requests that are missing the authorization parameter, and that the TXC receives the error message. Table 2 provides an example TXC request and TXS response that uses the Server Discovery Endpoint `/taxii2/`.

Table 2 - Missing Authorization Request and Response

TXC Request

`GET /taxii2/ HTTP/1.1`
`Host: 10.1.1.10`
`Accept: application/taxii+json;version=2.1`
`User-Agent: TAXII-Client/2.1`

TXS Response

`HTTP/1.1 401 UNAUTHORIZED`
`Content-Type: application/taxii+json;version=2.1`
`WWW-Authenticate: Basic realm="taxii", type=1, title="Login to \"apps\"", Basic realm="simple"`
 	
`{`
`  "title": "Unauthorized",`
`  "http_status": "401"`
`}`

3.1.2 Authorization Parameter Error Test Case

This test verifies that the TXS will respond with the appropriate error to client requests that include an incorrect authorization parameter, and that the TXC receives the error response from the TAXII Server. Table 3 provides an example TXC request and TXS response that uses the Server Discovery Endpoint `/taxii2/`.

Table 3 - Incorrect Authorization Parameter Request and Response

TXC Request

```
GET /taxii2/ HTTP/1.1
Host: 10.1.1.10
Accept: application/taxii+json;version=2.1
Authorization: Basic eererererere==
User-Agent: TAXII-Client/2.1
```

TXS Response

```
HTTP/1.1 401 UNAUTHORIZED
Content-Type: application/taxii+json;version=2.1
WWW-Authenticate: Basic realm="taxii", type=1, title="Login to \"apps\"", Basic
realm="simple"

{
  "title": "Unauthorized",
  "http_status": "401"
}
```

3.1.3 Certificate-Based Authentication Test Case

This test verifies that the TXC can authenticate to the server using a certificate, and that the TXS can process the request and deliver the appropriate response. Table 4 provides an example TXC request and TXS response that uses the Server Discovery Endpoint `/taxii2/`.

Table 4 - Certificate-based Authentication Request and Response

TXC Request

```
GET /taxii2/ HTTP/1.1
Host: 10.1.1.10
Accept: application/taxii+json;version=2.1
Authorization: MIIDBDCCAewCAQAwWTEXMBUGA1UEAwwOb2FzaXMtb3Blbi5vcmcxCzAJBgNVBAYT
AlVTMQswCQYDVQQIDAJWQTEPMA0GA1UEBwwGTWNMZWFuMRMwEQYDVQQKDApPQVNJ
UyBPUEVOMIIBIjANBgkqhkiG9w0BAQEFAAOCAQ8AMIIBCgKCAQEAxcCN04UKBCES
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yndti4UkBlZAePl3q5PtdOtA2glqA+3hmtq/vm1For1UWYJs0TMhS6iw+fgtJk6X
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oejSA73wfwIDAQABoGYwZAYJKoZIhvcNAQkOMVcwVTAOBgNVHQ8BAf8EBAMCBaAw
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WFc/3vvQkByhY/RN0eIZ3Lo9G87EGmTKZAx50yKJeKpR40sYfBG13AoaF/P2mh6T
rYzkG63jqL4=
User-Agent: TAXII-Client/2.1
```

TXS Response

```
HTTP/1.1 200 OK
Content-Type: application/taxii+json;version=2.1
```

```
{
  "title": "TAXII Server Under Test",
  "api_roots": [
    "https://10.1.1.10/api1/",
    "/api2/"
  ]
}
```

3.1.4 HTTP Basic Authentication Test Case

This test verifies that the TXC persona can authenticate with the TXS using HTTP Basic, and that the TXS can process the request and deliver the appropriate response. Support for absolute and relative paths is required for TXC, as seen in the response in Table 5.

Table 5 - HTTP Basic Authentication

TXC Request

```
GET /taxii2/ HTTP/1.1
Host: 10.1.1.10
Accept: application/taxii+json;version=2.1
Authorization: Basic aBVzdDpQXYZrdrByZCE=
User-Agent: TAXII-Client/2.1
```

TXS Response

```
HTTP/1.1 200 OK
Content-Type: application/taxii+json;version=2.1

{
  "title": "Test Case TAXII Server",
  "api_roots": [
    "https://10.1.1.10/api1/",
    "/api2/"
  ]
}
```

3.2 Server Discovery

This Endpoint `/taxii2/` provides general information about a TXS, including the advertised API Roots. It's a common entry point for TXCs into the data and services provided by a TXS. For example, TXCs auto-discovering TXSs via the DNS SRV record will be able to automatically retrieve a discovery response for that server by requesting the `/taxii2/` path on that domain. Please see section 4.1 of the TAXII 2.1 OASIS Standard for further details.

3.2.1 Get Discovery Resource Test Case

This test verifies that the TXC persona can request a Discovery Resource, and that the TXS can process the request and deliver the appropriate response. Support for absolute and relative paths is required for TXC, as seen in the response in Table 6.

Table 6 - Get Discovery Resource

TXC Request

```
GET /taxii2/ HTTP/1.1
Host: 10.1.1.10
Accept: application/taxii+json;version=2.1
Authorization: Basic dGVzdDpQYXNzdzByZCE=
User-Agent: TAXII-Client/2.1
```

TXS Response

```
HTTP/1.1 200 OK
Content-Type: application/taxii+json;version=2.1

{
  "title": "TAXII Server Under Test",
  "api_roots": [
    "https://10.1.1.10/api1/",
    "/api2/"
  ]
}
```

3.3 Get API Root Information

This Endpoint `{api-root}/` provides general information about an API Root, which can be used to help users and clients decide whether and how they want to interact with it. Multiple API Roots **MAY** be hosted on a single TAXII Server. Often, an API Root represents a single trust group. See section 4.2 of the TAXII 2.1 OASIS Standard for further details.

3.3.1 Get API Root Resource Test Case

This test verifies that the TXC persona can request an API-Root Resource, and that the TXS can process the request and deliver the appropriate response. Table 6 provides an example TXC request and TXS response. The test case shown in Table 7 builds on the required support for relative paths explained in section 3.2.

Table 7 - Get API Root Request and Response

TXC Request

```
GET /api2/ HTTP/1.1
Host: 10.1.1.10
Accept: application/taxii+json;version=2.1
Authorization: Basic dGVzdDpQYXNzdzByZCE=
User-Agent: TAXII-Client/2.1
```

TXS Response

```
HTTP/1.1 200 OK
Content-Type: application/taxii+json;version=2.1
```



```
{
  "title": "Sharing Group 2",
  "description": "This sharing group shares intelligence",
  "versions": [ "application/taxii+json;version=2.1" ],
  "max_content_length": 104857600
}
```

3.3.2 Incorrect API Root Information Test Case

This test verifies that the TXS can process the request and deliver the appropriate error response, and that the TXC can process the error response when making a request with an incorrect API Root. Table 8 provides an example request and response where the API Root requested (`api3`) does not exist (see section 3.4 for information about getting a Collections Resource).

Table 8 - Incorrect API Root Info Request and Response

TXC Request

```
GET /api3/ HTTP/1.1
Host: 10.1.1.10
Accept: application/taxii+json;version=2.1
Authorization: Basic dGVzdDpQYXNzdzByZCE=
User-Agent: TAXII-Client/2.1
```

TXS Response

```
HTTP/1.1 404 Not Found
Content-Type: application/taxii+json;version=2.1

{
  "title": "Not Found",
  "http_status": "404",
}
```

3.4 Get Collections

This Endpoint **`{api-root}/collections/`** provides information about the Collections hosted under this API Root. This provides information about all of the Collections. Most importantly, it provides the Collections' **`id`** properties, which are used to request objects or manifest entries from a Collection. If a client fails authentication then this endpoint **MUST** return an HTTP 401 (Unauthorized). Please see section 5.1 of the TAXII 2.1 OASIS Standard for further details.

3.4.1 Get Collections Resource Test Case

This test verifies that the TXC persona can request a Collections Resource, and that the TXS can process the request and deliver the appropriate response. Table 9 provides an example TXC request and TXS response.

Table 9 - Get Collections Request and Response

TXC Request

```
GET /api1/collections/ HTTP/1.1
Host: 10.1.1.10
Accept: application/taxii+json;version=2.1
Authorization: Basic dGVzdDpQYXNzdzByZCE=
User-Agent: TAXII-Client/2.1
```

TXS Response

```
HTTP/1.1 200 OK
Content-Type: application/taxii+json;version=2.1

{
  "collections": [
    {
      "id": "2d086da7-4bdc-4f91-900e-d77486753710",
      "title": "Some Collection",
      "can_read": true,
      "can_write": false
    },
    {
      "id": "66666666-4bdc-4f91-900e-d77486753710",
      "title": "Some Other Collection",
      "can_read": true,
      "can_write": false
    }
  ]
}
```

3.5 Get a Collection

This Endpoint `{api-root}/collections/{id}/` provides general information about a Collection, which can be used to help users and clients decide whether and how they want to interact with it. For example, it will tell TXCs what it's called and what permissions they have to it. If a TXC fails authentication then this endpoint **MUST** return an HTTP 401 (Unauthorized). Please see section 5.2 of the TAXII 2.1 OASIS Standard for further details.

3.5.1 Get Collection Resource Test Cases

Four different tests, corresponding to different read/write privileges, are used to verify that the TAXII Server will respond to a TAXII Client request for Collection resources, and that the TAXII Client can process the TAXII Server response.

3.5.1.1 Write-only Collection Resource Test Case

This test verifies that the TXC persona can request a write-only Collection Resource, and that the TXS can process the request and deliver the appropriate response. Table 10 provides an example TXC request and TXS response.

Table 10 - Get Collection Resource (Write-Only) Request and Response

TXC Request

```
GET /api1/collections/1105e147-e4c1-4566-8fb1-1046d181fbf8/ HTTP/1.1
Host: 10.1.1.10
Accept: application/taxii+json;version=2.1
Authorization: Basic dGVzdDpQYXNzdzByZCE=
User-Agent: TAXII-Client/2.1
```

TXS Response

```
HTTP/1.1 200 OK
Content-Type: application/taxii+json;version=2.1

{
  "id": "1105e147-e4c1-4566-8fb1-1046d181fbf8",
  "title": "Collection 1",
  "can_read": false,
  "can_write": true
}
```

3.5.1.2 Read-Write Collection Resource Test Case

This test verifies that the TXC persona can request a read-write Collection Resource, and that the TXS can process the request and deliver the appropriate response. Table 11 provides an example TXC request and TXS response.

Table 11 - Get Collection Resource (Read-Write) Request and Response

TXC Request

```
GET /api1/collections/378e5de7-84a4-45e4-8a34-c02a43d0b657/ HTTP/1.1
Host: 10.1.1.10
Accept: application/taxii+json;version=2.1
Authorization: Basic dGVzdDpQYXNzdzByZCE=
User-Agent: TAXII-Client/2.1
```

TXS Response

```
HTTP/1.1 200 OK
Content-Type: application/taxii+json;version=2.1

{
  "id": "378e5de7-84a4-45e4-8a34-c02a43d0b657",
  "title": "Collection 3",
  "can_read": true,
  "can_write": true
}
```

3.5.1.3 Read-only Collection Resource Test Case

This test verifies that the TXC persona can request a read-only Collection Resource, and that the TXS can process the request and deliver the appropriate response. Table 12 provides an example TXC request and TXS response.

Table 12 - Get Collection Resource (Read-Only) Request and Response

TXC Request

```
GET /api1/collections/253900d3-b9dd-46df-8184-469380fae6d2/ HTTP/1.1
Host: 10.1.1.10
Accept: application/taxii+json;version=2.1
Authorization: Basic dGVzdDpQYXNzdzByZCE=
User-Agent: TAXII-Client/2.1
```

TXS Response

```
HTTP/1.1 200 OK
Content-Type: application/taxii+json;version=2.1

{
  "id": "253900d3-b9dd-46df-8184-469380fae6d2",
  "title": "Collection 2",
  "can_read": true,
  "can_write": false
}
```

3.5.1.4 No-Read-No-Write Collection Resource Test Case

This test verifies that the TXC persona can request a no-read-no-write Collection Resource, and that the TXS can process the request and deliver the appropriate response. Table 13 provides an example TXC request and TXS response.

Table 13 - Get Collection Resource (No-Read-No-Write) Request and Response

TXC Request

```
GET /api1/collections/253900d3-b9dd-46df-8184-469380fae6d2/ HTTP/1.1
Host: 10.1.1.10
Accept: application/taxii+json;version=2.1
Authorization: Basic dGVzdDpQYXNzdzByZCE=
User-Agent: TAXII-Client/2.1
```

TXS Response

```
HTTP/1.1 200 OK
Content-Type: application/taxii+json;version=2.1

{
  "id": "253900d3-b9dd-46df-8184-469380fae6d2",
  "title": "Collection 4",
  "can_read": false,
```



```
  "can_write": false
}
```

3.5.2 Derived Authorization Errors

Four different tests, corresponding to different read/write privileges, are used to verify that the TXS will respond to a TXC request for Collection resources when the TXC does not have the required permission, and that the TXC can process the TXS response.

3.5.2.1 Read Request for Write-only Collection Test Case

This test verifies that the TXC persona can request to read a write-only Collection Resource, and that the TXS can process the request and deliver an HTTP 403 (Forbidden) error response. Examples of no-read collections are given in section 3.5.1.1 and section 3.5.1.4. Table 14 provides an example TXC request and TXS response.

Table 14 - Read Request for Write-only Collection Request and Response

TXC Request

```
GET /api1/collections/1105e147-e4c1-4566-8fb1-1046d181fbf8/objects/ HTTP/1.1
Host: 10.1.1.10
Accept: application/taxii+json;version=2.1
Authorization: Basic dGVzdDpQYXNzdzByZCE=
User-Agent: TAXII-Client/2.1
```

TXS Response

```
HTTP/1.1 403 Forbidden
Content-Type: application/taxii+json;version=2.1

{
  "title": "Forbidden",
  "http_status": "403"
}
```

3.5.2.2 Write Request to Read-only Collection Test Case

This test verifies that the TXC persona can request to write a read-only Collection Resource, and that the TXS can process the request and deliver an HTTP 403 (Forbidden) error response. Examples of no-write collections are given in section 3.5.1.3 and section 3.5.1.4. Table 15 provides an example TXC request and TXS response.

Table 15 - Write Request to Read-only Collection Request and Response

TXC Request

```
POST /api1/collections/1105e147-e4c1-4566-8fb1-1046d181fbf8/objects/ HTTP/1.1
Host: 10.1.1.10
Accept: application/taxii+json;version=2.1
Authorization: Basic dGVzdDpQYXNzdzByZCE=
Content-Type: application/taxii+json;version=2.1
User-Agent: TAXII-Client/2.1

{
  "objects": [
    {
      "type": "indicator",
      "id": "indicator--252c7c11-daf2-42bd-843b-be65edca9f61",
      "spec_version": "2.1",
      "name": "Bad IP1",
      "created_by_ref": "identity--f431f809-377b-45e0-aa1c-6a4751cae5ff",
      "created": "2018-01-17T11:11:13.000Z",
      "modified": "2018-01-17T11:11:13.000Z",
      "valid_from": "2018-01-01T00:00:00.000Z",
      "indicator_types": [ "malicious-activity" ],
      "pattern": "[ ipv4-addr:value = '198.51.100.1' ]",
      "pattern_type": "stix"
    }
  ]
}
```

TXS Response

```
HTTP/1.1 403 Forbidden
Content-Type: application/taxii+json;version=2.1

{
  "title": "Forbidden",
  "http_status": "403"
}
```

3.5.2.3 Delete Request to Read-only or Write-only Collection Test Case

This test verifies that the TXC persona can request to delete a read-only or write-only Collection Resource, and that the TXS can process the request and deliver an HTTP 403 (Forbidden) error response. An example of a write-only collection is given in section 3.5.1.1 and an example of a read-only collection is given in section 3.5.1.3. Table 16 provides an example TXC request and TXS response.

Table 16 - Delete Request to Read-only or Write-only Collection Request and Response

TXC Request

```
DELETE /api1/collections/91a7b528-80eb-42ed-a74d-c6fbd5a26116/objects/
indicator--252c7c11-daf2-42bd-843b-be65edca9f61/ HTTP/1.1
Host: 10.1.1.10
Accept: application/taxii+json;version=2.1
Authorization: Basic dGVzdDpQYXNzdzByZCE=
User-Agent: TAXII-Client/2.1
```

TXS Response


```
HTTP/1.1 403 Forbidden
Content-Type: application/taxii+json;version=2.1

{
  "title": "Forbidden",
  "http_status": "403"
}
```

3.5.2.4 Delete Request to No-Read, No-Write Collection Test Case

This test verifies that the TXC persona can request to delete a no-read, no-write Collection Resource, and that the TXS can process the request and deliver an HTTP 404 (Not Found) error response. An example of a no-read, no-write collection is given in section 3.5.1.4. Table 17 provides an example TXC request and TXS response.

Table 17 - Write Request to Read-Only Collection Request and Response

TXC Request
DELETE /api1/collections/91a7b528-80eb-42ed-a74d-c6fbd5a26116/objects/ indicator--252c7c11-daf2-42bd-843b-be65edca9f61/ HTTP/1.1 Host: 10.1.1.10 Accept: application/taxii+json;version=2.1 Authorization: Basic dGVzdDpQYXNzdzByZCE= User-Agent: TAXII-Client/2.1
TXS Response

HTTP/1.1 404 Not Found
Content-Type: application/taxii+json;version=2.1
 	
{
  "title": "Not Found",
  "http_status": "404"
}

3.5.3 Incorrect Collection Information Test Case

This test verifies that the TXC persona can request a Collection Resource using an incorrect Collection ID, and that the TXS can process the request and deliver an HTTP 404 (Not Found) error response, which the TXC can process. Table 18 provides an example TXC request and TXS response where the Collection, */api1/collections/d021ecc8-ab8e-41ab-815e-911c7e329f88/*, does not exist.

Table 18 - Incorrect Collection Info Request and Response

TXC Request
GET /api1/collections/d021ecc8-ab8e-41ab-815e-911c7e329f88/ HTTP/1.1 Host: 10.1.1.10 Accept: application/taxii+json;version=2.1 Authorization: Basic dGVzdDpQYXNzdzByZCE=


```
User-Agent: TAXII-Client/2.1
```

TXS Response

```
HTTP/1.1 404 Not Found
Content-Type: application/taxii+json;version=2.1

{
  "title": "Not Found",
  "http_status": "404"
}
```

3.6 Get Object Manifests

This Endpoint `{api-root}/collections/{id}/manifest/` retrieves a manifest about the objects in a Collection. It supports filtering identical to the Get Objects Endpoint, but rather than returning the object itself it returns metadata about the object. It can be used to retrieve metadata to decide whether it's worth retrieving the actual objects.

If a client fails authentication then this endpoint **MUST** return an HTTP 401 (Unauthorized). If the Collection specifies `can_read` as `false` for a particular client, this Endpoint **MUST** return an HTTP 403 (Forbidden) error.

See section 5.3 of the TAXII 2.1 OASIS Standard for further details. This endpoint supports filtering; see section 3.13 for details (example given in section 3.13.1.4). This endpoint supports pagination; for details see section 3.14. The common use case requirements from section 2.1 are applicable.

3.6.1 Get Manifest Resource Test Case

This test verifies that the TXC persona can request an Object Manifests Resource, and the TXS can process the request and deliver the appropriate response. Table 19 provides an example TXC request and TXS response.

Table 19 - Get Object Manifests Request and Response

TXC Request

```
GET /api1/collections/91a7b528-80eb-42ed-a74d-c6fbd5a26116/manifest/ HTTP/1.1
Host: 10.1.1.10
Accept: application/taxii+json;version=2.1
Authorization: Basic dGVzdDpQYXNzdzByZCE=
User-Agent: TAXII-Client/2.1
```

TXS Response

```
HTTP/1.1 200 OK
Content-Type: application/taxii+json;version=2.1
X-TAXII-Date-Added-First: 2018-01-18T11:11:13.000Z
X-TAXII-Date-Added-Last: 2019-01-18T11:11:13.000Z
```

```
{
  "objects": [
    {
      "id": "indicator--29aba82c-5393-42a8-9edb-6a2cb1df070b",
      "date_added": "2018-01-18T11:11:13.000Z",
      "version": "2018-01-18T11:11:13.000Z",
      "media_type": "application/stix+json;version=2.1"
    },
    {
      "id": "indicator--ef0b28e1-308c-4a30-8770-9b4851b260a5",
      "date_added": "2019-01-18T11:11:13.000Z",
      "version": "2019-01-18T11:11:13.000Z",
      "media_type": "application/stix+json;version=2.1"
    }
  ]
}
```

3.7 Get Objects

This Endpoint `{api-root}/collections/{id}/objects/` retrieves objects from a Collection. Clients can search for objects in the Collection, retrieve all objects in a Collection, or paginate through objects in the Collection. This is an endpoint for which pagination is applicable; see section 3.14 for details. The common use case requirements from section 2.1 are applicable.

If a client fails authentication then this endpoint **MUST** return an HTTP 401 (Unauthorized). If the Collection specifies `can_read` as `false` for a particular client, this Endpoint **MUST** return an HTTP 403 (Forbidden) error; an associated test case is given in section 3.5.2.1.

To support searching the Collection, this endpoint supports filtering. Clients can provide one or more filter parameters to get objects with a specific ID, of a specific type, or with a specific version. See section 3.13 for details.

See section 5.4 of the TAXII 2.1 OASIS Standard for further details about this endpoint.

3.7.1 Get Envelope Resource (Get Objects) Test Case

This test verifies that the TXC persona can request all objects from a collection, and the TXS can process the request and deliver the appropriate response.

Two examples are given below: Table 20 provides an example TXC request and TXS response where the TXC can read all the objects in a collection; Table 21 provides an example where the TXC can only read one object.

Table 20 - Get Objects Request and Response (access to all objects)

TXC Request
`GET /api1/collections/253900d3-b9dd-46df-8184-469380fae6d2/objects/ HTTP/1.1` `Host: 10.1.1.10`


```
Accept: application/taxii+json;version=2.1
Authorization: Basic dGVzdDpQYXNzdzByZCE=
User-Agent: TAXII-Client/2.1
```

TXS Response

```
HTTP/1.1 200 OK
Content-Type: application/taxii+json;version=2.1
X-TAXII-Date-Added-First: 2018-01-17T11:11:13.000Z
X-TAXII-Date-Added-Last: 2018-01-18T11:11:13.000Z

{
  "objects": [
    {
      "type": "indicator",
      "id": "indicator--cadd4d85-4ba3-5dd2-9e67-b7bf80bfc471",
      "spec_version": "2.1",
      "name": "Bad IP Subnets",
      "created_by_ref": "identity--f431f809-377b-45e0-aa1c-6a4751cae5ff",
      "created": "2018-01-17T11:11:13.000Z",
      "modified": "2018-01-17T11:11:13.000Z",
      "valid_from": "2018-01-01T00:00:00.000Z",
      "indicator_types": [ "malicious-activity" ],
      "pattern": "[ ipv4-addr:value ISSUBSET '198.51.100.0/24' OR ipv4-addr:value ISSUBSET
'196.45.200.0/24' ]",
      "pattern_type": "stix"
    },
    {
      "type": "indicator",
      "id": "indicator--57ec1fb8-7a4d-52ef-a18a-4018996dfbba",
      "spec_version": "2.1",
      "name": "Bad IP CIDR",
      "created_by_ref": "identity--f431f809-377b-45e0-aa1c-6a4751cae5ff",
      "created": "2018-01-18T11:11:13.000Z",
      "modified": "2018-01-18T11:11:13.000Z",
      "valid_from": "2018-01-01T00:00:00.000Z",
      "indicator_types": [ "malicious-activity" ],
      "pattern": "[ ipv4-addr:value ISSUBSET '198.51.100.0/24' ]",
      "pattern_type": "stix"
    }
  ]
}
```

Table 21 - Get Objects Request and Response (access to one object)

TXC Request

```
GET /api1/collections/253900d3-b9dd-46df-8184-469380fae6d2/objects/ HTTP/1.1
Host: 10.1.1.10
Accept: application/taxii+json;version=2.1
Authorization: Basic aHBbeSrWCAKfwjQvLCE=
User-Agent: TAXII-Client/2.1
```

TXS Response

```
HTTP/1.1 200 OK
```



```
Content-Type: application/taxii+json;version=2.1
X-TAXII-Date-Added-First: 2020-01-18T11:11:13.000Z
X-TAXII-Date-Added-Last: 2020-01-18T11:11:13.000Z

{
  "objects": [
    {
      "type": "indicator",
      "id": "indicator--5e679aec-a5ff-4718-8d99-c51d0aaad13c",
      "spec_version": "2.1",
      "name": "Malicious IP with CIDR",
      "created_by_ref": "identity--f431f809-377b-45e0-aa1c-6a4751cae5ff",
      "created": "2020-01-18T11:11:13.000Z",
      "modified": "2020-01-18T11:11:13.000Z",
      "valid_from": "2019-01-01T00:00:00.000Z",
      "indicator_types": [ "malicious-activity" ],
      "pattern": "[ ipv4-addr:value ISSUBSET '198.28.103.0/24' ]",
      "pattern_type": "stix"
    }
  ]
}
```

3.7.2 No Objects Test Case

This test verifies that the TXC persona can request all objects from an empty collection, and the TXS can process the request and deliver the appropriate response. Table 22 provides an example request and response where the collection requested *a346a557-a132-5233-b20e-3143d20a469c* contains no objects.

Table 22 - No Objects Request and Response

TXC Request

```
GET /api1/collections/a346a557-a132-5233-b20e-3143d20a469c/objects/ HTTP/1.1
Host: 10.1.1.10
Accept: application/taxii+json;version=2.1
Authorization: Basic dGVzdDpQYXNzdzByZCE=
User-Agent: TAXII-Client/2.1
```

TXS Response

```
HTTP/1.1 200 OK
Content-Type: application/taxii+json;version=2.1

{
}
```

3.8 Get an Object

This Endpoint `{api-root}/collections/{id}/objects/{object-id}/` gets an object from a Collection by its **`id`**. It can be thought of as a search where the `match[id]` parameter is set to the `{object-id}` in the path (see section 3.13 for filtering information).

If a client fails authentication then this endpoint **MUST** return an HTTP 401 (Unauthorized). If the Collection specifies `can_read` as `false` for a particular client, this Endpoint **MUST** return an HTTP 403 (Forbidden) error. To support getting a particular version of an object, this Endpoint supports filtering as defined in section 3.13.

See section 5.6 of the TAXII 2.1 OASIS Standard for further details. This endpoint supports filtering; see section 3.13 for details. This endpoint supports pagination; for details see section 3.14. The common use case requirements from section 2.1 are applicable.

3.8.1 Get Envelope Resource (Get an Object) Test Case

This test verifies that the TXC persona can request an object from a collection, and the TXS can process the request and deliver the appropriate response. Table 23 provides an example TXC request and TXS response.

Table 23 - Get an Object Request and Response

TXC Request

```
GET /api1/collections/91a7b528-80eb-42ed-a74d-c6fbd5a26116/objects/
indicator--252c7c11-daf2-42bd-843b-be65edca9f61/ HTTP/1.1
Host: 10.1.1.10
Accept: application/taxii+json;version=2.1
Authorization: Basic dGVzdDpQYXNzdzByZCE=
User-Agent: TAXII-Client/2.1
```

TXS Response

```
HTTP/1.1 200 OK
Content-Type: application/taxii+json;version=2.1
X-TAXII-Date-Added-First: 2020-12-03T12:30:59.000Z
X-TAXII-Date-Added-Last: 2020-12-03T12:30:59.000Z

{
  "objects": [
    {
      "type": "indicator",
      "id": "indicator--252c7c11-daf2-42bd-843b-be65edca9f61",
      "spec_version": "2.1",
      "name": "Bad IPv6-1",
      "created_by_ref": "identity--f431f809-377b-45e0-aa1c-6a4751cae5ff",
      "created": "2020-12-03T12:30:59.000Z",
      "modified": "2020-12-03T12:30:59.000Z",
      "valid_from": "2020-01-01T00:00:00.000Z",
      "indicator_types": [ "malicious-activity" ],
      "pattern": "[ ipv6-addr:value = '2001:0db8:85a3:0000:0000:8a2e:0370:7334' ]",
      "pattern_type": "stix"
    }
  ]
}
```

3.8.2 Object Not Found Test Case

This test verifies that the TXC persona can request a non-existent object from a collection, and the TXS can process the request and deliver the appropriate response. Table 24 provides an example request and response where the object requested `indicator--252c7c11-daf2-42bd-843b-be65edca9f61` does not exist.

Table 24 - Object Not Found Request and Response

TXC Request

```
GET /api1/collections/91a7b528-80eb-42ed-a74d-c6fbd5a26116/objects/
indicator--258e7d43-ae46-5081-bd12-bf09ab41b1ee/ HTTP/1.1
Host: 10.1.1.10
Accept: application/taxii+json;version=2.1
Authorization: Basic dGVzdDpQYXNzdzByZCE=
User-Agent: TAXII-Client/2.1
```

TXS Response

```
HTTP/1.1 404 Not Found
Content-Type: application/taxii+json;version=2.1

{
  "title": "Not Found",
  "http_status": "404"
}
```

3.9 Get Object Versions

This Endpoint `{api-root}/collections/{id}/objects/{object-id}/versions/` retrieves a list of one or more versions of an object in a Collection. This list can be used to decide whether it's worth retrieving the actual objects, or if new versions have been added. If a STIX object is not versioned (and therefore does not have a modified timestamp), the server **MUST** use the **`created`** timestamp. See section 5.8 of the TAXII 2.1 OASIS Standard for further details.

If a client fails authentication then this endpoint **MUST** return an HTTP 401 (Not Found) error. And if the Collection specifies **`can_read`** as false for a particular client, this endpoint **MUST** return an HTTP 403 (Forbidden) error.

This endpoint supports filtering; see section 3.13 for details. This endpoint supports pagination; for details see section 3.14. The common use case requirements from section 2.1 are applicable.

3.9.1 Get Versions Resource Test Case

This test verifies that the TXC persona can request a list of one or more versions of an object in a collection, and the TXS can process the request and deliver the appropriate response. Table 25 provides an example TXC request and TXS response.

Table 25 - Get Object Versions

TXC Request

```
GET /api1/collections/91a7b528-80eb-42ed-a74d-c6fbd5a26116/objects/
indicator--252c7c11-daf2-42bd-843b-be65edca9f61/versions/ HTTP/1.1
Host: 10.1.1.10
Accept: application/taxii+json;version=2.1
Authorization: Basic dGVzdDpQYXNzdzByZCE=
User-Agent: TAXII-Client/2.1
```

TXS Response

```
HTTP/1.1 200 OK
Content-Type: application/taxii+json;version=2.1
X-TAXII-Date-Added-First: 2020-11-03T12:30:59.000Z
X-TAXII-Date-Added-Last: 2021-12-04T01:23:45.000Z

{
  "versions": [
    "2020-11-03T12:30:59.000Z",
    "2021-12-04T01:23:45.000Z"
  ]
}
```

3.10 Add Objects

This Endpoint `{api-root}/collections/{id}/` adds objects to a Collection.

If a client fails authentication then this endpoint **MUST** return an HTTP 401 (Unauthorized). If the Collection specifies `can_write` as `false` for a particular client, this Endpoint **MUST** return an HTTP 403 (Forbidden) error; an associated test case is given in section 3.5.2.2.

Please see section 5.5 of the TAXII 2.1 OASIS Standard for further details.

3.10.1 Add Envelope Resource Test Case

This test verifies that the TXC persona can add objects to a collection, and the TXS can process the request and deliver the appropriate response. The TXS response **MUST** be processed to verify the correct total count of objects (**`total_count`**). In addition, the success count (**`success_count`**) **MUST** equal total count, and failure count (**`failure_count`**) and pending count (**`pending_count`**) **MUST** be zero. Table 26 provides an example TXC request and TXS response[1].

[1] *The UUID shown corresponds to the write-only collection. If the test is being performed for a write-read collection, then replace the UUID with an appropriate collection UUID.*

Table 26 - Indicator Publication POST Request and Response

TXC Request

```
POST /api1/collections/1105e147-e4c1-4566-8fb1-1046d181fbf8/objects/ HTTP/1.1
Host: 10.1.1.10
Accept: application/taxii+json;version=2.1
Authorization: Basic dGVzdDpQYXNzdzByZCE=
Content-Type: application/taxii+json;version=2.1
User-Agent: TAXII-Client/2.1

{

  "objects": [
    {
      "type": "indicator",
      "id": "indicator--252c7c11-daf2-42bd-843b-be65edca9f61",
      "spec_version": "2.1",
      "name": "Bad IP1",
      "created_by_ref": "identity--f431f809-377b-45e0-aa1c-6a4751cae5ff",
      "created": "2018-01-17T11:11:13.000Z",
      "modified": "2018-01-17T11:11:13.000Z",
      "valid_from": "2018-01-01T00:00:00.000Z",
      "indicator_types": [ "malicious-activity" ],
      "pattern": "[ ipv4-addr:value = '198.51.100.1' ]",
      "pattern_type": "stix"
    }
  ]
}
```

TXS Response

```
HTTP/1.1 202 Accepted
Content-Type: application/taxii+json;version=2.1

{
  "id": "2d086da7-4bdc-4f91-900e-d77486753710",
  "status": "complete",
  "total_count": 1,
  "success_count": 1,
  "failure_count": 0,
  "pending_count": 0
}
```

3.11 Get Status

This Endpoint **`{api-root}/status/{status-id}/`** provides information about the status of a previous request. In the TAXII 2.1 OASIS Standard, the only request that can be monitored is one to add objects to a Collection. It is typically used by TXCs to monitor a POST request that they made in order to take action when it is complete. TXS **MUST** accept queries for a given status ID for at least 24 hours after the server has finished processing the request. See section 4.3 of the TAXII 2.1 OASIS Standard for further details.

3.11.1 Get Status Resource Test Case

This test verifies that the TXC persona can request the status of a prior request, and the TXS can process the request and deliver the appropriate response. Table 27 provides an example TXC request and TXS response.

Table 27 - Get API Root Status Request and Response

TXC Request

```
GET /api1/status/2d086da7-4bdc-4f91-900e-d77486753710/ HTTP/1.1
Host: 10.1.1.10
Accept: application/taxii+json;version=2.1
Authorization: Basic dGVzdDpQYXNzdzByZCE=
User-Agent: TAXII-Client/2.1
```

TXS Response

```
HTTP/1.1 200 OK
Content-Type: application/taxii+json;version=2.1

{
  "id": "2d086da7-4bdc-4f91-900e-d77486753710",
  "status": "pending",
  "total_count": 4,
  "success_count": 2,
  "failure_count": 1,
  "pending_count": 1
}
```

3.11.2 Get All Status Properties Test Case

This test verifies that the TXC persona can request the status of a previous POST (see section 3.10), and the TXS can process the request and deliver all properties for the status-details and Status resources. Table 28 provides an example TXC request and TXS response. Support for all of the properties of status-details and Status resources is optional for the TXS but required for TXC.

Table 28 - Get All Status Properties Request and Response

TXC Request

```
GET /api1/status/2d086da7-4bdc-4f91-900e-d77486753710/ HTTP/1.1
Host: 10.1.1.10
Accept: application/taxii+json;version=2.1
Authorization: Basic dGVzdDpQYXNzdzByZCE=
User-Agent: TAXII-Client/2.1
```

TXS Response

```
HTTP/1.1 200 OK
Content-Type: application/taxii+json;version=2.1

{
  "id": "2d086da7-4bdc-4f91-900e-d77486753710",
  "status": "pending",
  "request_timestamp": "2016-11-02T12:34:34.12345Z",
  "total_count": 3,
  "success_count": 1,
  "successes": [
```

```
    {
      "id": "indicator--c410e480-e42b-47d1-9476-85307c12bcbf",
      "version": "2022-01-01T12:02:41.312Z",
      "message": "successfully processed!"
    }
  ],
  "failure_count": 1,
  "failures": [
    {
      "id": "indicator--19ef5a33-ef0f-43e0-82e6-8fdb02fb1fb0",
      "version": "2022-01-02T12:02:41.312Z",
      "message": "this object failed STIX validation"
    }
  ],
  "pending_count": 1,
  "pendings": [
    {
      "id": "indicator--b69a2dbd-6eeb-4a63-8796-80ce4bc2c704",
      "version": "2022-01-01T12:03:41.312Z",
      "message": "STIX validation in progress"
    }
  ]
}
```


3.12 Delete an Object

This Endpoint **`{api-root}`**`/collections/`**`{id}`**`/objects/`**`{object-id}`**`/` deletes an object from a Collection by its **`id`**. Please see section 5.7 of the TAXII 2.1 OASIS Standard for further details.

If a client fails authentication then this endpoint **MUST** return an HTTP 401 (Unauthorized).

If a TXC receives an HTTP 403 error status for this endpoint, then the TXC is recommended to review the **`can_read`** and **`can_write`** permissions it has with the TXS for the particular collection involved. The DELETE endpoint is only supported for collections where both **`can_read`** and **`can_write`** are true.

An HTTP 403 error is returned on this endpoint when only one of **`can_read`** and **`can_write`** is true; an associated test case is given in section 3.5.2.3.

An HTTP 404 error is returned on this endpoint when both **`can_read`** is true and **`can_write`** are false; an associated test case is given in section 3.5.2.4.

3.12.1 Delete Test Case

This test verifies that the TXC persona can delete an object from a collection, and the TXS can process the request and deliver the appropriate response. To confirm that the object was successfully deleted, the client should request the object (see section 3.8) and the server's response should be "404 Not Found" (see section 3.8.2). Table 29 provides an example TXC request and TXS response.

Table 29 - Delete Object Request and Response

TXC Request


```
DELETE /api1/collections/91a7b528-80eb-42ed-a74d-c6fbd5a26116/objects/
indicator--252c7c11-daf2-42bd-843b-be65edca9f61/ HTTP/1.1
Host: 10.1.1.10
Accept: application/taxii+json;version=2.1
Authorization: Basic dGVzdDpQYXNzdzByZCE=
User-Agent: TAXII-Client/2.1
```

TXS Response

```
HTTP/1.1 200 OK
Content-Type: application/taxii+json;version=2.1
```

3.13 Filter Results

A TXC can request specific content from a TXS by specifying a set of filters included in the request to the server. Please see section 3.4 of the TAXII 2.1 OASIS Standard for details.

Section 3.13.1 gives test cases for basic filtering as defined in the TAXII specification. The TAXII specification defines four URL query parameters (`add_after`, `limit`, `next`, `match[<field>]`) and four match fields (`id`, `type`, `version`, `spec_version`). Clients **MUST** be able to generate requests with multiple values for a single match parameter, and servers **MUST** be able to handle such requests; associated test cases are also given in section 3.13.1. Test cases for filtering with additional match fields are given in section 3.13.2.

3.13.1 Basic Filtering

Basic URL filtering parameters are not applicable to all Endpoints. The Endpoints to which filtering applies are shown in Table 30.

Table 30 - Endpoint Use of URL Filtering Parameters

URL Filtering Parameter	Get Object Manifests	Get Objects	Get an Object	Get Object Versions	Delete an Object
`added_after`	X	X	X	X	
`limit`	X	X	X	X	
`next`	X	X	X	X	
`match[id]`	X	X			
`match[type]`	X	X			
`match[version]`	X	X	X		X
`match[spec_version]`	X	X	X	X	X

An example for each of the URL filtering parameters is given below. While examples are not given for all Endpoints, the format and use is similar. Notes specific to each Endpoint type are as follows:

- The Get Object Manifests Endpoint supports the same filters as the Get Objects Endpoint. Filtering is applied against the source object rather than the manifest entry for an object. Thus, searching the manifest where **`type`** equals `indicator` will return the manifest entries for *objects* of `indicator` type, even though a manifest doesn't have a **`type`** property.
- The Get Objects Endpoint supports filtering a Collection. TAXII Clients can provide one or more filter parameters to get objects with a specific ID, of a specific type, or with a specific version.
- The Get an Object Endpoint uses `match[version]` to retrieve a particular version of an object.
- The Delete an Object Endpoint uses `match[version]` to support removing a particular version of an object.
- The `added_after` parameter is in no way related to dates or times in a STIX object or any other CTI object.
- The Get an Object Endpoint is equivalent to filtering the Get Objects Endpoint where the `match[id]` parameter is set to the `{object-id}` in the path.

3.13.1.1 added_after Test Case

This test verifies that the TXC persona can request objects that were added after a specified timestamp and the TXS can process the request and deliver the appropriate response by filtering the results. Table 31 provides an example TXC request and TXS response that includes the `added_after` URL query parameter.

Table 31 - Get Objects Request and Response with added_after URL Query Parameter

TXC Request

```
GET /api1/collections/253900d3-b9dd-46df-8184-469380fae6d2/objects/?added_after=2021-11-05T
10:30:061Z HTTP/1.1
Host: 10.1.1.10
Accept: application/taxii+json;version=2.1
Authorization: Basic dGVzdDpQYXNzdzByZCE=
User-Agent: TAXII-Client/2.1
```

TXS Response

```
HTTP/1.1 200 OK
Content-Type: application/taxii+json;version=2.1
X-TAXII-Date-Added-First: 2019-01-17T11:11:13.000Z
X-TAXII-Date-Added-Last: 2019-01-17T11:11:13.000Z

{
  "objects": [
    {
      "type": "indicator",
      "id": "indicator--11dabf1d-71a8-42f4-aa97-2c8a5962f697",
      "spec_version": "2.1",
      "name": "Malicious URL",
      "created_by_ref": "identity--f431f809-377b-45e0-aa1c-6a4751cae5ff",
      "created": "2019-01-17T11:11:13.000Z",
      "modified": "2019-01-17T11:11:13.000Z",
      "valid_from": "2019-01-01T00:00:00.000Z",
      "indicator_types": [ "malicious-activity" ],
      "pattern": "[ url:value = 'https://www.9a6.info/bar' ]",
      "pattern_type": "stix"
    }
  ]
}
```

When using this filter with the Get an Object Endpoint, the object requested will only be returned if it was added after the specified timestamp. Table 32 shows the response when the object was added before the specified timestamp (no object found).

Table 32 - Get an Object Request and Response with added_after URL Query Parameter

TXC Request

```
GET /api1/collections/91a7b528-80eb-42ed-a74d-c6fbd5a26116/objects/
indicator--252c7c11-daf2-42bd-843b-be65edca9f61/?added_after=2021-11-05T10:30:061Z HTTP/1.1
Host: 10.1.1.10
Accept: application/taxii+json;version=2.1
Authorization: Basic dGVzdDpQYXNzdzByZCE=
User-Agent: TAXII-Client/2.1
```

TXS Response

```
HTTP/1.1 200 OK
Content-Type: application/taxii+json;version=2.1
```



```
{
}
```

3.13.1.2 limit Test Case

This test verifies that the TXC persona can limit the number of objects returned in a request, and the TXS can process the request and deliver the appropriate response by filtering the results. For brevity, the process of pagination to obtain the remaining results is not shown in this test case; an example of the pagination process is given in section 3.14. Table 33 provides an example TXC request and TXS response that includes the `limit` URL query parameter.

Table 33 - Get Object Manifests Request and Response: limit URL Query Parameter

TXC Request

```
GET /api1/collections/91a7b528-80eb-42ed-a74d-c6fbd5a26116/manifest/?limit=2 HTTP/1.1
Host: 10.1.1.10
Accept: application/taxii+json;version=2.1
Authorization: Basic dGVzdDpQYXNzdzByZCE=
User-Agent: TAXII-Client/2.1
```

TXS Response

```
HTTP/1.1 200 OK
Content-Type: application/taxii+json;version=2.1
X-TAXII-Date-Added-First: 2018-01-17T11:11:13.000Z
X-TAXII-Date-Added-Last: 2018-01-19T11:11:13.000Z

{
  "more": true,
  "objects": [
    {
      "id": "indicator--69a4eedb-05c5-463b-ba59-65257d652cf4",
      "date_added": "2018-01-17T11:11:13.000Z",
      "version": "2018-01-17T11:11:13.000Z",
      "media_type": "application/stix+json;version=2.1"
    },
    {
      "id": "indicator--7d663616-ab3d-4097-b195-ace869edefc5",
      "date_added": "2018-01-19T11:11:13.000Z",
      "version": "2018-01-19T11:11:13.000Z",
      "media_type": "application/stix+json;version=2.1"
    }
  ]
}
```

3.13.1.3 match[id] Test Case

This test verifies that the TXC persona can request objects that match a given identifier (`id`), and the TXS can process the request and deliver the appropriate response by filtering the results. Table 34 provides an example TXC request and TXS response.

Table 34 - Get Objects Request and Response with match[id]

TXC Request

```
GET /api1/collections/253900d3-b9dd-46df-8184-469380fae6d2/objects/?match[id]=indicator --
3600ad1b-fff1-4c98-bcc9-4de3bc2e2ffb HTTP/1.1
Host: 10.1.1.10
Accept: application/taxii+json;version=2.1
Authorization: Basic dGVzdDpQYXNzdzByZCE=
User-Agent: TAXII-Client/2.1
```

TXS Response

```
HTTP/1.1 200 OK
Content-Type: application/taxii+json;version=2.1
X-TAXII-Date-Added-First: 2018-03-17T11:11:13.000Z
X-TAXII-Date-Added-Last: 2018-03-17T11:11:13.000Z

{
  "objects": [
    {
      "type": "indicator",
      "id": "indicator--fb07bb1e-9745-489f-9a4c-b17bf1e7aab1",
      "spec_version": "2.1",
      "name": "Possibly Malicious Domain",
      "created_by_ref": "identity--f431f809-377b-45e0-aa1c-6a4751cae5ff",
      "created": "2018-03-17T11:11:13.000Z",
      "modified": "2018-03-17T11:11:13.000Z",
      "valid_from": "2018-02-01T00:00:00.000Z",
      "indicator_types": [ "malicious-activity" ],
      "pattern": "[ domain-name:value = 'www.1234foobar.info' ]",
      "pattern_type": "stix"
    }
  ]
}
```

3.13.1.4 match[type] Test Cases

Two test cases are given below for filtering on **`type`**. The first filters a Get Objects request; the second filters a Get Objects Manifest request.

This test verifies that the TXC persona can request objects that match a given type (`type`), and the TXS can process the request and deliver the appropriate response by filtering the results. Table 35 provides an example TXC request and TXS response.

Table 35 - Get Objects Request and Response with match[type]

TXC Request

```
GET /api1/collections/253900d3-b9dd-46df-8184-469380fae6d2/objects/?match[type]=indicator
HTTP/1.1
Host: 10.1.1.10
Accept: application/taxii+json;version=2.1
Authorization: Basic dGVzdDpQYXNzdzByZCE=
User-Agent: TAXII-Client/2.1
```

TXS Response

```
HTTP/1.1 200 OK
Content-Type: application/taxii+json;version=2.1
X-TAXII-Date-Added-First: 2018-01-17T11:11:13.000Z
X-TAXII-Date-Added-Last: 2018-01-17T11:11:13.000Z

{
  "objects": [
    {
      "type": "indicator",
      "id": "indicator--6cce5ca8-34c0-4ae8-b603-0bda82504dfd",
      "spec_version": "2.1",
      "name": "Bad URL or Domain",
      "created_by_ref": "identity--f431f809-377b-45e0-aa1c-6a4751cae5ff",
      "created": "2018-01-17T11:11:13.000Z",
      "modified": "2018-01-17T11:11:13.000Z",
      "valid_from": "2018-01-01T00:00:00.000Z",
      "indicator_types": [ "malicious-activity" ],
      "pattern": "[ url:value = 'https://www.5z8.info/foo' OR domain-name:value =
'www.5z8.info' ]",
      "pattern_type": "stix"
    }
  ]
}
```

This test verifies that the TXC persona can request objects that match a given type (`type`), and the TXS can process the request and deliver the appropriate response by filtering the results. Table 36 provides an example TXC request and TXS response.

Table 36 - Get Object Manifest Request and Response with match[type]

TXC Request

```
GET /api1/collections/253900d3-b9dd-46df-8184-469380fae6d2/manifest/?match[type]=indicator
HTTP/1.1
Host: 10.1.1.10
Accept: application/taxii+json;version=2.1
Authorization: Basic dGVzdDpQYXNzdzByZCE=
User-Agent: TAXII-Client/2.1
```

TXS Response

```
HTTP/1.1 200 OK
Content-Type: application/taxii+json;version=2.1
X-TAXII-Date-Added-First: 2018-01-17T11:11:13.000Z
X-TAXII-Date-Added-Last: 2018-12-19T11:11:13.000Z

{
  "objects": [
    {
      "id": "indicator--69a4eedb-05c5-463b-ba59-65257d652cf4",
      "date_added": "2018-01-17T11:11:13.000Z",
      "version": "2018-01-17T11:11:13.000Z",
      "media_type": "application/stix+json;version=2.1"
    },
    {
      "id": "indicator--indicator--6cce5ca8-34c0-4ae8-b603-0bda82504dfd",
      "date_added": "2018-01-17T11:11:13.000Z",
      "version": "2018-01-17T11:11:13.000Z",
      "media_type": "application/stix+json;version=2.1"
    }
  ]
}
```

3.13.1.5 match[version] Test Case

This test verifies that the TXC persona can request objects that match a given version (`version`), and the TXS can process the request and deliver the appropriate response by filtering the results. Table 37 provides an example TXC request and TXS response.

The version is determined by an object's **modified** timestamp. If an object is not versioned and therefore does not have a **modified** date property, then the version **MUST** be determined by the **created** timestamp. If an object does not have a **created** or **modified** timestamp, then the version **MUST** be determined by the **date_added** timestamp of the Manifest-Record resource (see section 5.3.1 of the TAXII 2.1 OASIS Standard), which is when the object was added to the server.

Table 37 - Get Objects Request and Response with match[version]

TXC Request

```
GET /api1/collections/253900d3-b9dd-46df-8184-469380fae6d2/objects/indicator--252c7c11-daf2-
42bd-843b-be65edca9f61/?match[version]=last HTTP/1.1
Host: 10.1.1.10
Accept: application/taxii+json;version=2.1
Authorization: Basic dGVzdDpQYXNzdzByZCE=
User-Agent: TAXII-Client/2.1
```

TXS Response

```
HTTP/1.1 200 OK
Content-Type: application/taxii+json;version=2.1
X-TAXII-Date-Added-First: 2021-12-04T01:23:45.000Z
X-TAXII-Date-Added-Last: 2021-12-04T01:23:45.000Z

{
  "objects": [
    {
      "type": "indicator",
      "id": "indicator--cca8e422-8f15-48de-98f7-d0ab7767acfe",
      "spec_version": "2.1",
      "name": "Bad URL or Domain",
      "created_by_ref": "identity--f431f809-377b-45e0-aa1c-6a4751cae5ff",
      "created": "2021-12-04T01:23:45.000Z",
      "modified": "2021-12-04T01:23:45.000Z",
      "valid_from": "2020-02-01T00:00:00.000Z",
      "indicator_types": [ "malicious-activity" ],
      "pattern": "[ url:value = 'https://www.2a1.info/foobar' ]",
      "pattern_type": "stix"
    }
  ]
}
```

3.13.1.6 match[spec_version] Test Case

This test verifies that the TXC persona can retrieve objects that match a given specification version (`spec_version`), and the TXS can process the request and deliver the appropriate response by filtering the results. Table 38 provides an example TXC request and TXS response that includes the `spec_version` URL query parameter.

Table 38 - Delete Object Request and Response

TXC Request

```
GET /api1/collections/91a7b528-80eb-42ed-a74d-c6fbd5a26116/objects/?match[spec_version]=2.1
HTTP/1.1
Host: 10.1.1.10
Accept: application/taxii+json;version=2.1
Authorization: Basic dGVzdDpQYXNzdzByZCE=
User-Agent: TAXII-Client/2.1
```


TXS Response

```
HTTP/1.1 200 OK
Content-Type: application/taxii+json;version=2.1
X-TAXII-Date-Added-First: 2019-12-04T01:23:45.000Z
X-TAXII-Date-Added-Last: 2020-10-04T01:23:45.000Z

{
  "objects": [
    {
      "type": "indicator",
      "id": "indicator--7abcd230-9d0d-4386-857f-7e995783e86c",
      "spec_version": "2.1",
      "name": "Possibly Malicious URL or Domain",
      "created_by_ref": "identity--f431f809-377b-45e0-aa1c-6a4751cae5ff",
      "created": "2019-12-04T01:23:45.000Z",
      "modified": "2019-12-04T01:23:45.000Z",
      "valid_from": "2020-02-01T00:00:00.000Z",
      "indicator_types": [ "malicious-activity" ],
      "pattern": "[ url:value = 'https://www.123abc.info/foobar' ]",
      "pattern_type": "stix"
    },
    {
      "type": "indicator",
      "id": "indicator--c8a8015c-79f1-4121-9634-0661a3df94fc",
      "spec_version": "2.1",
      "name": "Malicious URL",
      "created_by_ref": "identity--f431f809-377b-45e0-aa1c-6a4751cae5ff",
      "created": "2020-10-04T01:23:45.000Z",
      "modified": "2020-10-04T01:23:45.000Z",
      "valid_from": "2020-02-01T00:00:00.000Z",
      "indicator_types": [ "malicious-activity" ],
      "pattern": "[ url:value = 'https://www.xyz987.info/barfoo' ]",
      "pattern_type": "stix"
    }
  ]
}
```

3.13.1.7 Logical OR Operator Test Case

This test verifies that the TXC persona can utilize the logical OR operator in a request, and the TXS can process the request and deliver the appropriate response by filtering the results. Table 39 provides an example TXC request and TXS response.

Table 39 - Get Objects Request and Response using logical OR operator

TXC Request

```
GET /api1/collections/253900d3-b9dd-46df-8184-469380fae6d2/objects/?match[type]=campaign,
threat-actor HTTP/1.1
Host: 10.1.1.10
Accept: application/taxii+json;version=2.1
Authorization: Basic dGVzdDpQYXNzdzByZCE=
User-Agent: TAXII-Client/2.1
```

TXS Response

```
HTTP/1.1 200 OK
Content-Type: application/taxii+json;version=2.1
X-TAXII-Date-Added-First: 2016-04-06T20:03:48.000Z
X-TAXII-Date-Added-Last: 2021-04-06T20:03:00.000Z

{
  "objects": [
    {
      "type": "campaign",
      "spec_version": "2.1",
      "id": "campaign--208f342f-1f18-48a1-a898-0a66b04f1b7d",
      "created_by_ref": "identity--f431f809-377b-45e0-aa1c-6a4751cae5ff",
      "created": "2020-04-06T20:03:00.000Z",
      "modified": "2020-04-06T20:03:00.000Z",
      "name": "Brown Group Attacks Against Commerce"
    },
    {
      "type": "campaign",
      "spec_version": "2.1",
      "id": "campaign--a4b9e39d-f51f-4c47-8cda-61852cbf93d3",
      "created_by_ref": "identity--f431f809-377b-45e0-aa1c-6a4751cae5ff",
      "created": "2021-04-06T20:03:00.000Z",
      "modified": "2021-04-06T20:03:00.000Z",
      "name": "Pink Group Attacks Against Energy"
    },
    {
      "type": "threat-actor",
      "spec_version": "2.1",
      "id": "threat-actor--8e2e2d2b-17d4-4cbf-938f-98ee46b3cd3f",
      "created_by_ref": "identity--f431f809-377b-45e0-aa1c-6a4751cae5ff",
      "created": "2016-04-06T20:03:48.000Z",
      "modified": "2016-04-06T20:03:48.000Z",
      "threat_actor_types": [ "crime-syndicate" ],
      "name": "Evil Org",
      "description": "The Evil Org threat actor group",
      "roles": [ "director" ],
      "sophistication": "advanced",
      "resource_level": "team",
      "primary_motivation": "organizational-gain"
    }
  ]
}
```

3.13.1.8 Logical AND Operator Test Case

This test verifies that the TXC persona can utilize the logical AND operator in a request, and the TXS can process the request and deliver the appropriate response by filtering the results. Table 40 provides an example TXC request and TXS response.

Table 40 - Get Objects Request and Response using logical AND operator

TXC Request

```
GET /api1/collections/253900d3-b9dd-46df-8184-469380fae6d2/objects/?match[type]=indicator&
match[id]=indicator--e9af88c8-e101-413a-a8d1-f869ad6d79b3 HTTP/1.1
Host: 10.1.1.10
Accept: application/taxii+json;version=2.1
Authorization: Basic dGVzdDpQYXNzdzByZCE=
User-Agent: TAXII-Client/2.1
```

TXS Response

```
HTTP/1.1 200 OK
Content-Type: application/taxii+json;version=2.1
X-TAXII-Date-Added-First: 2022-01-17T11:11:13.000Z
X-TAXII-Date-Added-Last: 2022-01-17T11:11:13.000Z

{
  "objects": [
    {
      "type": "indicator",
      "id": "indicator--e9af88c8-e101-413a-a8d1-f869ad6d79b3",
      "spec_version": "2.1",
      "name": "Bad IP2",
      "created_by_ref": "identity--f431f809-377b-45e0-aa1c-6a4751cae5ff",
      "created": "2022-01-17T11:11:13.000Z",
      "modified": "2022-01-17T11:11:13.000Z",
      "valid_from": "2022-01-01T00:00:00.000Z",
      "indicator_types": [ "malicious-activity" ],
      "pattern": "[ ipv4-addr:value = '199.55.102.3' ]",
      "pattern_type": "stix"
    }
  ]
}
```

3.13.1.9 Logical OR and AND Operators Test Case

This test verifies that the TXC persona can utilize the logical OR and AND operators in a request, and the TXS can process the request and deliver the appropriate response by filtering the results. Table 41 provides an example TXC request and TXS response.

Table 41 - Get Objects Request and Response using logical OR and AND operators

TXC Request

```
GET /api1/collections/253900d3-b9dd-46df-8184-469380fae6d2/objects/?match[type]=campaign,
malware&match[version]=first,last HTTP/1.1
Host: 10.1.1.10
Accept: application/taxii+json;version=2.1
Authorization: Basic dGVzdDpQYXNzdzByZCE=
User-Agent: TAXII-Client/2.1
```

TXS Response

```
HTTP/1.1 200 OK
Content-Type: application/taxii+json;version=2.1
X-TAXII-Date-Added-First: 2019-05-12T08:17:27.000Z
X-TAXII-Date-Added-Last: 2021-07-06T20:03:00.000Z

{
  "objects": [
    {
      "type": "malware",
      "spec_version": "2.1",
      "id": "malware--6f8a1ea6-6655-492b-a5e1-8d02b993b10e",
      "created": "2019-05-12T08:17:27.000Z",
      "modified": "2019-05-12T08:17:27.000Z",
      "created_by_ref": "identity--c78cb6e5-0c4b-4611-8297-d1b8b55e40b5",
      "name": "Cryptolocker",
      "malware_types": [ "ransomware" ],
      "is_family": false,
      "capabilities": [ "anti-vm" ],
      "first_seen": "2021-01-18T11:11:13.000Z",
      "last_seen": "2021-01-18T11:11:13.000Z",
      "implementation_langauges": [ "python", "c" ],
      "architecture_execution_envs": [ "mips", "x86" ]
    },
    {
      "type": "campaign",
      "spec_version": "2.1",
      "id": "campaign--ff24310c-7dd9-4768-826d-b6fcd6519cdb",
      "created_by_ref": "identity--f431f809-377b-45e0-aa1c-6a4751cae5ff",
      "created": "2021-07-06T20:03:00.000Z",
      "modified": "2021-07-06T20:03:00.000Z",
      "name": "Magenta Group Attacks Against Finance"
    }
  ]
}
```

3.13.1.10 Duplicate Filter Parameter Test Case

This test verifies that the TXS will respond with the appropriate error to client requests that include the same filter parameter multiple times, and that the TXC receives the error message. Table 42 provides an example TXC request and TXS response.

Table 42 - Get Objects Request and Response using logical OR and AND operators

TXC Request

```
GET /api1/collections/253900d3-b9dd-46df-8184-
469380fae6d2/objects/?match[type]=campaign&match[type]=malware HTTP/1.1
Host: 10.1.1.10
Accept: application/taxii+json;version=2.1
Authorization: Basic dGVzdDpQYXNzdzByZCE=
User-Agent: TAXII-Client/2.1
```

TXS Response

```
HTTP/1.1 400 Bad Request
Content-Type: application/taxii+json;version=2.1

{
  "title": "Bad Request",
  "http_status": "400"
}
```

3.13.2 Filtering with Additional Match Fields

Additional match fields can be used with the Get Object Manifests and Get Objects Endpoints. Three classes of additional match fields are defined (see Appendix B: TAXII Additional Match Filters). The three tiers in the Tiered class **MUST** be verified in sequence. Test cases for each class are given below.

3.13.2.1 Tier 1 Test Case

This test verifies that the TXC persona can request objects using a Tier 1 match field (e.g., `confidence`) and the TXS can process the request and deliver the appropriate response by filtering the results. Table 43 provides an example TXC request and TXS response. See the Tier 1 section of Appendix B for all Tier 1 filters.

Table 43 - Get Objects Request and Response with match[confidence]

TXC Request

```
GET /api1/collections/253900d3-b9dd-46df-8184-469380fae6d2/objects/?match[confidence]=90,91,
92,93,94 HTTP/1.1
Host: 10.1.1.10
Accept: application/taxii+json;version=2.1
Authorization: Basic dGVzdDpQYXNzdzByZCE=
User-Agent: TAXII-Client/2.1
```

TXS Response

```
HTTP/1.1 200 OK
Content-Type: application/taxii+json;version=2.1
X-TAXII-Date-Added-First: 2020-02-06T20:03:48.000Z
X-TAXII-Date-Added-Last: 2020-04-06T20:03:00.000Z

{
  "objects": [
    {
      "type": "indicator",
      "id": "indicator--844cf084-2229-45d5-9764-c3c6ed978d77",
      "spec_version": "2.1",
      "confidence": 90,
      "created_by_ref": "identity--f431f809-377b-45e0-aa1c-6a4751cae5ff",
      "created": "2020-02-06T20:03:48.000Z",
      "modified": "2020-02-06T20:03:48.000Z",
      "indicator_types": [ "benign" ],
      "name": "Benign site",
      "pattern": "[ url:value = 'http://weibo.com' ]",
      "pattern_type": "stix",
      "valid_from": "2020-01-01T00:00:00Z"
    },
    {
      "type": "campaign",
      "id": "campaign--5bd6a633-769b-4211-8f6d-a4567941e4c1",
      "spec_version": "2.1",
      "confidence": 93,
      "created_by_ref": "identity--f431f809-377b-45e0-aa1c-6a4751cae5ff",
      "created": "2020-04-06T20:03:00.000Z",
      "modified": "2020-04-06T20:03:00.000Z",
      "name": "Yellow Group Attacks Against Finance"
    }
  ]
}
```

3.13.2.2 Tier 2 Test Case

This test verifies that the TXC persona can request objects using a Tier 2 match field (e.g., `capabilities`) and the TXS can process the request and deliver the appropriate response by filtering the results. Table 44 provides an example TXC request and TXS response. See the Tier 2 section of Appendix B for all Tier 2 filters.

Table 44 - Get Objects Request and Response with match[capabilities]

TXC Request

```
GET /api1/collections/253900d3-b9dd-46df-8184-469380fae6d2/objects/?match[capabilities]=
emails-spam HTTP/1.1
Host: 10.1.1.10
Accept: application/taxii+json;version=2.1
Authorization: Basic dGVzdDpQYXNzdzByZCE=
User-Agent: TAXII-Client/2.1
```

TXS Response

```
HTTP/1.1 200 OK
Content-Type: application/taxii+json;version=2.1
X-TAXII-Date-Added-First: 2019-05-12T08:17:27.000Z
X-TAXII-Date-Added-Last: 2019-05-12T08:17:27.000Z

{
  "objects": [
    {
      "type": "malware",
      "id": "malware--afae2bf9-c5e3-49d8-8e12-8d4c5829f35f",
      "spec_version": "2.1",
      "capabilities": [ "emails-spam", "anti-debugging" ],
      "created": "2019-05-12T08:17:27.000Z",
      "modified": "2019-05-12T08:17:27.000Z",
      "created_by_ref": "identity--c78cb6e5-0c4b-4611-8297-d1b8b55e40b5",
      "name": "EmailLocker",
      "malware_types": [ "ransomware" ],
      "is_family": false,
      "first_seen": "2017-01-18T11:11:13.000Z",
      "last_seen": "2017-01-18T11:11:13.000Z",
      "implementation_langauges": [ "python", "c" ],
      "architecture_execution_envs": [ "mips", "x86" ]
    },
    {
      "type": "malware",
      "id": "malware--f2e6e92c-2979-49d6-b52e-7a07d2bd38b4",
      "spec_version": "2.1",
      "capabilities": [ "emails-spam" ],
      "created": "2019-05-12T08:17:27.000Z",
      "modified": "2019-05-12T08:17:27.000Z",
      "created_by_ref": "identity--c78cb6e5-0c4b-4611-8297-d1b8b55e40b5",
      "name": "KeyLogger",
      "malware_types": [ "keylogger" ],
      "is_family": false,
      "first_seen": "2017-01-18T11:11:13.000Z",
      "last_seen": "2017-01-18T11:11:13.000Z",
      "implementation_langauges": [ "python", "c" ],
      "architecture_execution_envs": [ "mips", "x86" ]
    }
  ]
}
```


3.13.2.3 Tier 3 Test Case

This test verifies that the TXC persona can request objects using a Tier 3 match field (e.g., `service_status`) and the TXS can process the request and deliver the appropriate response by filtering the results. Table 45 provides an example TXC request and TXS response. See the Tier 3 section of Appendix B for all Tier 3 filters.

Table 45 - Get Objects Request and Response with match[service_status]

TXC Request

```
GET /api1/collections/253900d3-b9dd-46df-8184-469380fae6d2/objects/?match[service_status]=
SERVICE_STOPPED HTTP/1.1
Host: 10.1.1.10
Accept: application/taxii+json;version=2.1
Authorization: Basic dGVzdDpQYXNzdzByZCE=
User-Agent: TAXII-Client/2.1
```

TXS Response

```
HTTP/1.1 200 OK
Content-Type: application/taxii+json;version=2.1
X-TAXII-Date-Added-First: 2019-05-12T08:17:27.000Z
X-TAXII-Date-Added-Last: 2019-05-12T08:17:27.000Z

{
  "objects": [
    {
      "type": "process",
      "spec_version": "2.1",
      "id": "process--70b17c6c-93e5-4c80-8683-5a4d4e51f2c1",
      "pid": 2217,
      "command_line": "C:\\Windows\\System32\\sirvizio.exe /s",
      "image_ref": "file--3916128d-69af-5525-be7a-99fac2383a59",
      "extensions": {
        "windows-service-ext": {
          "service_name": "sirvizio",
          "display_name": "Sirvizio",
          "start_type": "SERVICE_AUTO_START",
          "service_type": "SERVICE_WIN32_OWN_PROCESS",
          "service_status": "SERVICE_STOPPED"
        }
      }
    }
  ]
}
```

3.13.2.4 Relationships Test Case

This test verifies that the TXC persona can request objects using a Relationships match field (e.g., `relationships-all`) and the TXS can process the request and deliver the appropriate response by filtering the results. Table 46 provides an example TXC request and TXS response. See the Relationships Match section of Appendix B for all Relationships Match filters.

Table 46 - Get Objects Request and Response with match[relationships-all]

TXC Request

```
GET /api1/collections/253900d3-b9dd-46df-8184-469380fae6d2/objects/?match[relationships-
all]= indicator--3600ad1b-fff1-4c98-bcc9-4de3bc2e2ffb HTTP/1.1
Host: 10.1.1.10
Accept: application/taxii+json;version=2.1
Authorization: Basic dGVzdDpQYXNzdzByZCE=
User-Agent: TAXII-Client/2.1
```

TXS Response

```
HTTP/1.1 200 OK
Content-Type: application/taxii+json;version=2.1
X-TAXII-Date-Added-First: 2016-04-06T20:08:31.000Z
X-TAXII-Date-Added-Last: 2016-04-06T20:08:31.000Z

{
  "objects": [
    {
      "type": "sighting",
      "spec_version": "2.1",
      "id": "sighting--ee20065d-2555-424f-ad9e-0f8428623c75",
      "created_by_ref": "identity--f431f809-377b-45e0-aa1c-6a4751cae5ff",
      "created": "2016-04-06T20:08:31.000Z",
      "modified": "2016-04-06T20:08:31.000Z",
      "sighting_of_ref": "indicator--3600ad1b-fff1-4c98-bcc9-4de3bc2e2ffb",
      "count": 50,
      "first_seen": "2017-12-21T19:00:00.000Z",
      "last_seen": "2018-01-06T19:00:00.000Z",
    },
    {
      "type": "relationship",
      "spec_version": "2.1",
      "id": "relationship--44298a74-ba52-4f0c-87a3-1824e67d7fad",
      "created_by_ref": "identity--f431f809-377b-45e0-aa1c-6a4751cae5ff",
      "created": "2016-04-06T20:06:37.000Z",
      "modified": "2016-04-06T20:06:37.000Z",
      "relationship_type": "indicates",
      "source_ref": "indicator--3600ad1b-fff1-4c98-bcc9-4de3bc2e2ffb",
      "target_ref": "malware--31b940d4-6f7f-459a-80ea-9c1f17b5891b"
    }
  ]
}
```

3.13.2.5 Calculation Test Case

This test verifies that the TXC persona can request objects using a Calculation match field (e.g., `confidence-gte`) and the TXS can process the request and deliver the appropriate response by filtering the results. Table 47 provides an example TXC request and TXS response. See the Calculation Match section of Appendix B for all Calculation Match filters.

Table 47 - Get Objects Request and Response with match[confidence-gte]

TXC Request

```
GET /api1/collections/253900d3-b9dd-46df-8184-469380fae6d2/objects/?match[confidence-gte]=
91 HTTP/1.1
Host: 10.1.1.10
Accept: application/taxii+json;version=2.1
Authorization: Basic dGVzdDpQYXNzdzByZCE=
User-Agent: TAXII-Client/2.1
```

TXS Response

```
HTTP/1.1 200 OK
Content-Type: application/taxii+json;version=2.1
X-TAXII-Date-Added-First: 2016-04-06T20:03:00.000Z
X-TAXII-Date-Added-Last: 2016-04-06T20:03:00.000Z

{
  "objects": [
    {
      "type": "campaign",
      "id": "campaign--4779a4c3-6f0a-4ec2-90ba-5ee32bde736a",
      "spec_version": "2.1",
      "confidence": 93,
      "created_by_ref": "identity--f431f809-377b-45e0-aa1c-6a4751cae5ff",
      "created": "2016-04-06T20:03:00.000Z",
      "modified": "2016-04-06T20:03:00.000Z",
      "name": "Orange Group Attacks Against Healthcare"
    }
  ]
}
```

3.14 Pagination

TAXII 2.1 supports pagination of large result sets on certain endpoints. Pagination is used when a TXS has more content to send to a TXC than will fit in a single TAXII container resource (see section 1.1). This **MAY** be a result of a TXS limitation and/or a TXC-specified limit. Should a TXS have more content than will fit in a single TAXII container resource, the TXS is to use pagination by divvying up the results and sending the content via multiple TAXII container resources. These endpoints return results sorted in ascending order by the date they were added to the collection.

For TXS responses containing a TAXII container resource object that has the **more** property set to true, a timestamp-based approach can be utilized by a TXC to paginate through the remaining results. Specifically, from the TXS response, a TXC can pass the date/time value from the X-TAXII-Date-Added-Last header, along with the same original query options, as the added_after URL parameter. The value of the header will change with subsequent requests. If a TXS has more results than can fit in a single TAXII container resource, it **MUST** set the value of **more** to true; when there are no remaining records to be requested, the value of **more MUST** be false. A TXC SHOULD NOT provide a value for **more**.

Pagination is applicable for the following endpoints:

URL	Methods	Resource Type
{api-root}/collections/**{id}**/manifest/	GET	`manifest`
{api-root}/collections/**{id}**/objects/	GET	`envelope`
{api-root}/collections/**{id}**/objects/**{object-id}**/	GET	`envelope`
{api-root}/collections/**{id}**/objects/**{object-id}**/versions/	GET	`versions`

For further details, please see section 3.5 of the TAXII 2.1 OASIS Standard.

3.14.1 Pagination Test Case

This test case is a follow-on to the test case shown in section 3.9.1; this test case illustrates the process used to paginate through results when a TXC requests to retrieve all versions of a particular object within a collection.

From a TXS perspective, this test case will demonstrate the initial and subsequent TXC requests, and the delivery of all of the results across multiple Versions Resources. For this test case, the TXS has a limit of three versions per Versions Resource. This general process is also used when a TXS responds with Manifest Resources or TAXII Envelopes.

First, the TXC requests all of the versions for a particular object within a particular collection; this object will have five versions. The TXS responds with a single object version and sets **more** to true.

Table 48 - Get Object Versions Initial Request

TXC Request

```
GET /api1/collections/91a7b528-80eb-42ed-a74d-c6fbd5a26116/objects/
indicator--252c7c11-daf2-42bd-843b-be65edca9f61/versions/ HTTP/1.1
Host: 10.1.1.10
Accept: application/taxii+json;version=2.1
Authorization: Basic dGVzdDpQYXNzdzByZCE=
User-Agent: TAXII-Client/2.1
```

TXS Response

```
HTTP/1.1 200 OK
Content-Type: application/taxii+json;version=2.1
X-TAXII-Date-Added-First: 2020-11-03T12:30:59.000Z
X-TAXII-Date-Added-Last: 2020-11-03T12:30:59.000Z

{
```

```
  "more": true,
  "versions": [
    "2020-04-03T12:30:59.000Z",
    "2021-05-03T12:30:59.000Z",
    "2022-06-03T12:30:59.000Z"
  ]
}
```

Next, the TXC receives a Versions Resource with **more** set to true, and so the TXC makes another request to obtain the remaining records. This time, the TXC passes the provided value of X-TAXII-Date-Added-Last as the added-after URL parameter.

Table 49 - Get Object Versions Subsequent Request

TXC Request

```
GET /api1/collections/91a7b528-80eb-42ed-a74d-c6fbd5a26116/objects/
indicator--252c7c11-daf2-42bd-843b-be65edca9f61/versions/?added-after=2020-11-
03T12:30:59.000Z HTTP/1.1
Host: 10.1.1.10
Accept: application/taxii+json;version=2.1
Authorization: Basic dGVzdDpQYXNzdzByZCE=
User-Agent: TAXII-Client/2.1
```

TXS Response

```
HTTP/1.1 200 OK
Content-Type: application/taxii+json;version=2.1
X-TAXII-Date-Added-First: 2020-12-04T12:30:59.000Z
X-TAXII-Date-Added-Last: 2020-12-04T12:30:59.000Z

{
  "versions": [
    "2022-11-04T12:30:59.000Z",
    "2022-12-04T12:30:59.000Z"
  ]
}
```

3.15 Custom Properties

Custom property names **MUST** start with “x_” followed by a source unique identifier, an underscore, and then the name. For the purposes of Interoperability, the source unique identifier is to be a globally-unique identifier (GUID). The GUID **MUST** be a UUIDv4. The UUID **MUST** be generated according to [RFC 4122].

A TXS that receives a TAXII resource with one or more custom properties it does not understand **MUST** ignore the non-understood properties and continue processing the message. In addition, a TXS **MUST** store the complete responses, including the non-understood properties. Logging policies (e.g., retention, retrieval) are beyond the scope of this document.

A TXC that receives a TAXII resource with one or more custom properties it does not understand **MAY** ignore the non-understood properties, but **MUST** continue processing the message. In addition, a TXC

MUST store the complete responses, including the non-understood properties. Logging policies (e.g., retention, retrieval) are beyond the scope of this document.

3.15.1 Custom Properties Test Case

The TXC submits a POST request to add an object to a Collection on the TXS. The TXC also includes a custom property named *x_18467e42_04f4_4505_93c8_9f1cf29e1045_test_client*, where "18467e42_04f4_4505_93c8_9f1cf29e1045" is the TXC's GUID. This property is received by but not understood by the TXS, and thus the TXS ignores this property but continues with the remainder of the request.

In a similar fashion, the TXS then responds with content that includes a custom property named *x_f18dd923-7fdd-4c5c-94f3-807f556bce6b_test_server*, where "f18dd923-7fdd-4c5c-94f3-807f556bce6b" is the TXS's GUID. This property is received by but not understood by the TXC, and thus the TXC ignores this property but continues with the remainder of the request. Both the TXS and the TXC log the entirety of the custom property content to internal storage.

Both the server and client receive content with properties they do not understand and yet they're interoperable.

Table 50 - Indicator Publication POST Request and Response

TXC Request

```
POST /api1/collections/1105e147-e4c1-4566-8fb1-1046d181fbf8/objects/ HTTP/1.1
Host: 10.1.1.10
Accept: application/taxii+json;version=2.1
Authorization: Basic dGVzdDpQYXNzdzByZCE=
Content-Type: application/taxii+json;version=2.1
User-Agent: TAXII-Client/2.1

{
  "objects": [
    {
      "type": "indicator",
      "id": "indicator--252c7c11-daf2-42bd-843b-be65edca9f61",
      "spec_version": "2.1",
      "name": "Bad IP1",
      "created_by_ref": "identity--f431f809-377b-45e0-aa1c-6a4751cae5ff",
      "created": "2018-01-17T11:11:13.000Z",
      "modified": "2018-01-17T11:11:13.000Z",
      "valid_from": "2018-01-01T00:00:00.000Z",
      "indicator_types": [ "malicious-activity" ],
      "pattern": "[ ipv4-addr:value = '198.51.100.1' ]",
      "pattern_type": "stix"
    }
  ],
  "x_18467e42_04f4_4505_93c8_9f1cf29e1045_test_client": "The Client sends the Server a
custom property."
}
```

TXS Response

```
HTTP/1.1 202 Accepted
Content-Type: application/taxii+json;version=2.1

{
  "id": "2d086da7-4bdc-4f91-900e-d77486753710",
  "status": "complete",
  "total_count": 1,
  "success_count": 1,
  "failure_count": 0,
  "pending_count": 0,
  "x_f18dd923_7fdd_4c5c_94f3_807f556bce6b_test_server": "The Server sends the Client a
custom property."
}
```


4 Persona Checklist

The following checklists summarize all tests that a persona **MUST** conform to within that persona.

4.1 TAXII Client (TXC)

For the purpose of this document, a `TXC` is a software package that connects to a TAXII Server and supports the exchange of CTI.

Any instance being qualified as a `TXC` **MUST** confirm test results for the following use cases.

Table 51 - TAXII Client (TXC) Test Verification List

Test Case	Section	Verification	Results
Missing Authorization Parameter	3.1.1	Mandatory	<fill in>
Authorization Parameter Error	3.1.2	Mandatory	<fill in>
Certificate-Based Authentication	3.1.3	Mandatory	<fill in>
HTTP Basic Authentication	3.1.4	Mandatory	<fill in>
Get Discovery Resource	3.2.1	Mandatory	<fill in>
Get API Root Resource	3.3.1	Mandatory	<fill in>
Incorrect API Root Information	3.3.2	Mandatory	<fill in>
Get Collections Resource	3.4.1	Mandatory	<fill in>
Write-Only Collection Resource	3.5.1.1	Mandatory	<fill in>
Read-Write Collection Resource	3.5.1.2	Mandatory	<fill in>
Read-Only Collection Resource	3.5.1.3	Mandatory	<fill in>
No-Read-No-Write Collection Resource	3.5.1.4	Mandatory	<fill in>
Read Request for Write-only Collection	3.5.2.1	Mandatory	<fill in>
Write Request to Read-only Collection	3.5.2.2	Mandatory	<fill in>
Delete Request to Read-only or Write-only Collection	3.5.2.3	Mandatory	<fill in>
Delete Request to No-Read, No-Write Collection	3.5.2.4	Mandatory	<fill in>

Incorrect Collection Information	3.5.3	Mandatory	<fill in>
Get Manifest Resource	3.6.1	Mandatory	<fill in>
Get Envelope Resource (Get Objects)	3.7.1	Mandatory	<fill in>
No Objects	3.7.2	Mandatory	<fill in>
Get Envelope Resource (Get an Object)	3.8.1	Mandatory	<fill in>
Object Not Found	3.8.2	Mandatory	<fill in>
Get Versions Resource	3.9.1	Mandatory	<fill in>
Add Envelope Resource	3.10.1	Mandatory	<fill in>
Get Status Resource	3.11.1	Mandatory	<fill in>
Get All Status Properties	3.11.2	Mandatory	<fill in>
Delete	3.12.1	Mandatory	<fill in>
added_after	3.13.1.1	Mandatory	<fill in>
limit	3.13.1.2	Mandatory	<fill in>
match[id]	3.13.1.3	Mandatory	<fill in>
match[type]	3.13.1.4	Mandatory	<fill in>
match[version]	3.13.1.5	Mandatory	<fill in>
match[spec_version]	3.13.1.6	Mandatory	<fill in>
Logical OR Operator	3.13.1.7	Mandatory	<fill in>
Logical AND Operator	3.13.1.8	Mandatory	<fill in>
Logical OR and AND Operators	3.13.1.9	Mandatory	<fill in>
Duplicate Filter Parameter	3.13.1.10	Mandatory	<fill in>
Tier 1	3.13.2.1	Optional	<fill in>
Tier 2	3.13.2.2	Optional	<fill in>
Tier 3	3.13.2.3	Optional	<fill in>
Relationships	3.13.2.4	Optional	<fill in>

Calculation	3.13.2.5	Optional	<fill in>
Pagination	3.14.1	Mandatory	<fill in>
Custom Properties	3.15.1	Mandatory	<fill in>

4.2 TAXII Server (TXS)

For the purpose of this document, a TXS is a software package that supports the exchange of CTI.

Any instance being qualified as a TXS **MUST** confirm test results for the following use cases. *At least one of Certificate-Based Authentication (3.1.3) and HTTP Basic Authentication (3.1.4) must be implemented.

Table 52 — TAXII Server (TXS) Test Verification List

Test Case	Section	Verification	Results
Missing Authorization Parameter	3.1.1	Mandatory	<fill in>
Authorization Parameter Error	3.1.2	Mandatory	<fill in>
Certificate-Based Authentication*	3.1.3	Optional	<fill in>
HTTP Basic Authentication*	3.1.4	Optional	<fill in>
Get Discovery Resource	3.2.1	Mandatory	<fill in>
Get API Root Resource	3.3.1	Mandatory	<fill in>
Incorrect API Root Information	3.3.2	Mandatory	<fill in>
Get Collections Resource	3.4.1	Mandatory	<fill in>
Write-Only Collection Resource	3.5.1.1	Mandatory	<fill in>
Read-Write Collection Resource	3.5.1.2	Mandatory	<fill in>
Read-Only Collection Resource	3.5.1.3	Mandatory	<fill in>
No-Read-No-Write Collection Resource	3.5.1.4	Mandatory	<fill in>
Read Request for Write-only Collection	3.5.2.1	Mandatory	<fill in>
Write Request to Read-only Collection	3.5.2.2	Mandatory	<fill in>
Delete Request to Read-only or Write-only Collection	3.5.2.3	Mandatory	<fill in>

Delete Request to No-Read, No-Write Collection	3.5.2.4	Mandatory	<fill in>
Incorrect Collection Information	3.5.3	Mandatory	<fill in>
Get Manifest Resource	3.6.1	Mandatory	<fill in>
Get Envelope Resource (Get Objects)	3.7.1	Mandatory	<fill in>
No Objects	3.7.2	Mandatory	<fill in>
Get Envelope Resource (Get an Object)	3.8.1	Mandatory	<fill in>
Object Not Found	3.8.2	Mandatory	<fill in>
Get Versions Resource	3.9.1	Mandatory	<fill in>
Add Envelope Resource	3.10.1	Mandatory	<fill in>
Get Status Resource	3.11.1	Mandatory	<fill in>
Get All Status Properties	3.11.2	Optional	<fill in>
Delete	3.12.1	Mandatory	<fill in>
added_after	3.13.1.1	Mandatory	<fill in>
limit	3.13.1.2	Mandatory	<fill in>
match[id]	3.13.1.3	Mandatory	<fill in>
match[type]	3.13.1.4	Mandatory	<fill in>
match[version]	3.13.1.5	Mandatory	<fill in>
match[spec_version]	3.13.1.6	Mandatory	<fill in>
Logical OR Operator	3.13.1.7	Mandatory	<fill in>
Logical AND Operator	3.13.1.8	Mandatory	<fill in>
Logical OR and AND Operators	3.13.1.9	Mandatory	<fill in>
Duplicate Filter Parameter	3.13.1.10	Mandatory	<fill in>
Tier 1	3.13.2.1	Optional	<fill in>
Tier 2	3.13.2.2	Optional	<fill in>
Tier 3	3.13.2.3	Optional	<fill in>

Relationships	3.13.2.4	Optional	<fill in>
Calculation	3.13.2.5	Optional	<fill in>
Pagination	3.14.1	Mandatory	<fill in>
Custom Properties	3.15.1	Mandatory	<fill in>

Appendix A. References

This appendix contains the normative and informative references that are used in this document. Normative references are specific (identified by date of publication and/or edition number or version number) and Informative references are either specific or non-specific. For specific references, only the cited version applies. For non-specific references, the latest version of the reference document (including any amendments) applies. While any hyperlinks included in this appendix were valid at the time of publication, OASIS cannot guarantee their long term validity.

Informative References

The following referenced documents are not required for the application of this document but **MAY** assist the user with regard to a particular subject area.

[RFC3986]
Uniform Resource Identifier (URI): Generic Syntax, January 2005, https://www.rfc-editor.org/info/rfc3986.

[RFC4122]
A Universally Unique IDentifier (UUID) URN Namespace, July 2005, https://www.rfc-editor.org/info/rfc4122.

[RFC7540]
Hypertext Transfer Protocol Version 2 (HTTP/2), May 2015, https://www.rfc-editor.org/info/rfc7540.

Appendix B. TAXII Additional Match Fields

Introduction

A TAXII Client can request specific content from a TAXII Server by specifying a set of filters included in the request to the server. Please see the TAXII specification for details [SPEC].

This document focuses on the match URL query parameter, which defines filtering on a specified field. Four match fields are defined in the TAXII specification (`id`, `spec_version`, `type`, `version`). Requests **MAY** use a field not defined in [SPEC], and servers **MAY** ignore fields they do not understand.

This document defines additional fields for the match URL query parameter. Please consider the following when using additional match fields.

- **Special characters**: Any special characters such as white space, question marks, and commas **MUST** be encoded as a character triplet, consisting of the percent character "%" followed by the two hexadecimal digits representing that octet's numeric value [RFC3986].

- **Default values**: Some properties are optional, have default values, and **MAY** not be present. They have specific interpretation in the STIX specification. For example, the **`revoked`** property is optional and if not present, the object is considered valid. The filter `?match[revoked]=false` will return objects that have not been revoked (the **`revoked`** property is not present or equals `false`).

- **List type**: Properties of type `list` can be checked for specific values. If any one of the values in the match filter is present, the object will be returned. For example, consider the `object_refs` field of type `list` of type `identifier`.

  ```
  "object_refs": [
    "indicator--26ffb872-1dd9-446e-b6f5-d58527e5b5d2",
    "campaign--83422c77-904c-4dc1-aff5-5c38f3a2c55c",
    "relationship--f82356ae-fe6c-437c-9c24-6b64314ae68a",
    "file--0203b5c8-f8b6-4ddb-9ad0-527d727f968b"
  ]
  ```

  The filter, `?match[object_refs]=campaign--83422c77-904c-4dc1-aff5-5c38f3a2c55c` will return the associated object.

  It is not possible to filter for objects that contain a list type field with *all* values in a set because a field **MUST NOT** occur more than once in a filter request.

- **Dictionary type**: Properties of type dictionary can be filtered for specific dictionary key values. For example, consider an X.509 Certificate object with a `hashes` field of type `hashes`.

  ```
  "hashes": {
      "SHA-256": "effb46bba03f6c8aea5c653f9cf984f170dcdd3bbbe2ff6843c3e5da0e698766",
      "MD5": "9e04af713d91d493ef3301a050a18b7a"
      "SHA-1": "8bd560c15248aa8a2473d6fdbd0e83f202c891a9"
    },
  ```

The filter `?match[MD5]=9e04af713d91d493ef3301a050a18b7a` or the filter `?match[SHA-1]=8bd560c15248aa8a2473d6fdbd0e83f202c891a9` will return the associated X.509 Certificate object.

- **String type**: Although spaces are not allowed on either side of a comma separating multiple values in a filter, properties of type string can be filtered, even if the string contains white space. For example, the filter, `?match[subject]=please open me,happy birthday` is valid.

  As mentioned above special characters such as white space **MUST** be encoded. So, as an example "%20" corresponds to the space character, so the match filter example in the previous paragraph would be encoded as `?match[subject]=please%20open%20me,happy%20birthday`.

  String matching is case-insensitive.

Additional match fields are shown in the subsections below. Tiered match fields should be implemented sequentially, but the relationships and calculation match fields can be implemented independently.

Tiered Match Fields

Property-based match fields have been divided into three tiers based on the structure of STIX 2.1. Match fields are alphabetized within each tier.

- **Tier 1**: match fields correspond to simple top-level properties of STIX objects.
- **Tier 2**: match fields correspond to array elements (lists) defined as top-level properties of STIX objects.
- **Tier 3**: match fields correspond to properties defined within nested structures.

Tier 1

Tier 1 match fields correspond to simple top-level properties of STIX objects. Properties with value type `identifier` that reference a relationship (end in "_ref") are defined in the Relationship class (see Relationships Match).

Match Field	Description

`account_type`	The type of **User Account** object.
	
	Value type: `account-type-ov`
	
	Examples
	`?match[account_type]=windows-local`
	`?match[account_type]=facebook,skype`

`confidence`	The **`confidence`** value applied to any STIX object(s).
	
	Value type: `integer`
	
	Examples
	`?match[confidence]=90`
	`?match[confidence]=90,91,92,93,94,95,96,97,98,99,100`

`context`	A short descriptor of the particular context shared by the content referenced by the **Grouping** object.
	Value type: `grouping-context-ov`
	Examples
	`?match[context]=suspicious-activity`
	`?match[context]=malware-analysis,unspecified`

`data_type`	The data type of the **Windows Registry Value** object.
	Value type: `windows-registry-datatype-enum`
	Examples
	`?match[data_type]=REG_BINARY`
	`?match[data_type]=REG_DWORD_BIG_ENDIAN,REG_DWORD_LITTLE_ENDIAN`

`dst_port`	The destination port used in a **Network Traffic** object.
	Value type: `integer`
	Examples
	`?match[dst_port]=1040`
	`?match[dst_port]=88841,83452`

`encryption_algorithm`	Specifies the type of encryption algorithm used to encode the binary data of an **Artifact** object.
	Value type: `encryption-algorithm-enum`
	Examples
	`?match[encryption_algorithm]=mime-type-indicated`
	`?match[encryption_algorithm]=AES-256-GCM,ChaCha20-Poly1305`

`identity_class`	The type of entity that an **Identity** object describes.
	Value type: `identity-class-ov`
	Examples
	`?match[identity_class]=individual`
	`?match[identity_class]=individual,group`

`name`	The name of objects (**Attack Pattern**, **Campaign**, **Course of Action**, **Grouping**, **Identity**, **Incident**, **Indicator**, **Infrastructure**, **Intrusion Set**, **Location**, **Malware**, **Report**, **Threat Actor**, **Tool**, **Vulnerability**, **Autonomous System (AS)**, **File**, **Mutex**, **Software**, **Marking Definition**, **Extension Definition**) and types (**Alternate Data Stream**, **Windows PE Section**, **Windows Registry Value**).
	Value type: `string`
	Examples
	`?match[name]=__CLEANSWEEP__`
	`?match[name]=Green%20Group%20Attackers,Panda%20Cubs%20United`

`number`	The number assigned to an **Autonomous System** object.
	Value type: `integer`
	Examples
	`?match[number]=15139`
	`?match[number]=19347,3954`

`opinion`	The opinion value present in an **Opinion** object.
	Value type: `opinion-enum`
	Examples
	`?match[opinion]=agree`
	`?match[opinion]=agree,strongly-agree`

`pattern`	The detection pattern for an **Indicator** object.
	Value type: `string`
	Examples
	`?match[pattern]=[file:hashes.'SHA-256' = '4bac27393bdd9777ce02453256c5577cd02275510b2227f473d03f533924f877']`
	`?match[pattern]=[file:hashes.MD5 = '3773a88f65a5e780c8dff9cdc3a056f3'],[file:hashes.'SHA-256' = 'ef537f25c895bfa782526529a9b63d97aa631564d5d789c2b765448c8635fb6c']`

`pattern_type`	The pattern language used in an **Indicator** object.
	Value type: `pattern-type-ov`
	Examples
	`?match[pattern_type]=stix`
	`?match[pattern_type]=sigma,snort`

`primary_motivation`	The primary reason, motivation, or purpose behind an **Intrusion Set** object or **Threat Actor** object.
	Value type: `attack-motivation-ov`
	Examples
	`?match[primary_motivation]=revenge`
	`?match[primary_motivation]=organization-gain,personal-gain`

`region`	The region a **Location** object describes.
	
	Value type: `region-ov`
	
	Examples
	`?match[region]=europe`
	`?match[region]=caribbean,south-america`

`relationship_type`	The type of relationship between the source and target objects in a **Relationship** object.
	
	Value type: `string`
	
	Examples
	`?match[relationship_type]=indicates`
	`?match[relationship_type]=indicates,uses`

`resource_level`	The organizational level at which an **Intrusion Set** object or **Threat Actor** object typically works, which determines the resources available for use in an attack.
	
	Value type: `attack-resource-level-ov`
	
	Examples
	`?match[resource_level]=government`
	`?match[resource_level]=team,organization`

`result`	The classification result of the **Malware Analysis** object as determined by the scanner or tool analysis process.
	
	Value type: `malware-result-ov`
	
	Examples
	`?match[result]=malicious`
	`?match[result]=benign,unknown`

`revoked`	Returns STIX objects based on the **`revoked`** property. The **`revoked`** property is optional and has specific interpretation in the STIX specification. For example, if the **`revoked`** property is not present, the object is considered valid (default is `false`).
	
	● ?match[revoked]=true will return objects that have been revoked (the **`revoked`** property equals `true`).
	● ?match[revoked]=false will return objects that have not been revoked (the **`revoked`** property is not present or equals `false`).
	
	Value type: `boolean`
	
	Examples
	`?match[revoked]=false`
	`?match[revoked]=true`

`src_port`	The source port used in a **Network Traffic** object.
	Value type: `integer`
	Examples
	`?match[src_port]=9081`
	`?match[src_port]=3372,24638`

`sophistication`	The skill, specific knowledge, special training, or expertise a **Threat Actor** object **MUST** have to perform an attack.
	Value type: `threat-actor-sophistication-ov`
	Examples
	`?match[sophistication]=none`
	`?match[sophistication]=expert,innovator`

`subject`	Specifies the subject of an **Email Message** or **X.509 Certificate** object.
	Value type: `string`
	Examples
	`?match[subject]=happy%20birthday`
	`?match[subject]=see%20this%20joke,funny%20photo`

`value`	The value present in STIX SCOs **ipv4-addr**, **ipv6-addr**, **domain-name**, **email-addr**, **mac-addr**, and **url** objects value property.
	Value type: `string`
	Examples
	`?match[value]=198.51.100.3`
	`?match[value]=john@example.com,doe@example.com`

Tier 2

Tier 2 match fields correspond to array elements (lists) defined as top-level properties of STIX objects. Properties with value type `identifier` that reference relationships (end in "_refs") are defined in the Relationships class.

Match Field	Description

`aliases`	Alternative names used to identify **Attack Pattern**, **Campaign**, **Infrastructure**, **Intrusion Set**, **Malware**, **Threat Actor**, and **Tool** objects.
	Value type: `string`
	Examples
	`?match[aliases]=Zookeeper`
	`?match[aliases]=Syndicate%201,Evil%20Syndicate%2099`

`architecture_executions_envs`	The processor architectures that **Malware** object is executable on.
	Value type: `processor-architecture-ov`
	Examples
	`?match[architecture_executions_envs]=x86`
	`?match[architecture_executions_envs]=x86,x86-64`

`capabilities`	The capabilities of **Malware** object.
	Value type: `malware-capabilities-ov`
	Examples
	`?match[capabilities]=emails-spam`
	`?match[capabilities]=anti-debugging,anti-disassembly`

`extension_types`	The type of the **Extension** meta-object.
	Value type: `extension-type-enum`
	Examples
	`?match[extension_types]=new-sdo`
	`?match[extension_types]=new-sdo,new-sco`

`implementation_languages`	The programming language used to implement **Malware** object.
	Value type: `implementation-language-ov`
	Examples
	`?match[implementation_languages]=visual-basic`
	`?match[implementation_languages]=java,php`

`indicator_types`	The category of an **Indicator** object.
	Value type: `indicator-type-ov`
	Examples
	`?match[indicator_types]=anonymization`
	`?match[indicator_types]=compromised,malicious-activity`

`infrastructure_types`	The type of **Infrastructure** object.
	Value type: `infrastructure-type-ov`
	Examples
	`?match[infrastructure_types]=botnet`
	`?match[infrastructure_types]=phishing,reconnaissance`

`labels`	The label value(s) applied to any STIX object.
	Value type: `string`
	Examples
	`?match[labels]=trickbot`
	`?match[labels]=totbrick,tspy_trickload`

`malware_types`	The category of **Malware** object.
	Value type: `malware-type-ov`
	Examples
	`?match[malware_types]=bot`
	`?match[malware_types]=virus,worm`

`personal_motivations`	The personal reasons, motivations, or purposes of a **Threat Actor** object, regardless of organizational goals.
	Value type: `attack-motivation-ov`
	Examples
	`?match[personal_motivations]=accidental`
	`?match[personal_motivations]=ideology,notoriety`

`report_types`	The primary type of content found in a **Report** object.
	Value type: `report-type-ov`
	Examples
	`?match[report_types]=indicator`
	`?match[report_types]=malware,tool`

`roles`	The roles performed by the **Identity** object.
	Value type: `string`
	Examples
	`?match[labels]=ceo`
	`?match[labels]=doctor,hospital`

`roles`	The roles played by a **Threat Actor** object.
	Value type: `threat-actor-role-ov`
	Examples
	`?match[roles]=malware-author`
	`?match[roles]=agent,director`

`secondary_motivations`	The secondary reasons, motivations, or purposes behind an **Intrusion Set** object or **Threat Actor** object.
	Value type: `attack-motivation-ov`
	Examples
	`?match[secondary_motivations]=ideology`
	`?match[secondary_motivations]=dominance,revenge`

`sectors`	The sectors property defined in an **Identity** object.
	Value type: `industry-sector-ov`
	Examples
	`?match[sectors]=energy`
	`?match[sectors]=financial-services,manufacturing`

`threat_actor_types`	The type of **Threat Actor** object.
	Value type: `threat-actor-type-ov`
	Examples
	`?match[threat_actor_types]=criminal`
	`?match[threat_actor_types]=nation-state,terrorist`

`tool_types`	The type of **Tool** object.
	Value type: `tool-type-ov`
	Examples
	`?match[capabilities]=network-capture`
	`?match[capabilities]=credential-exploitation,remote-access`

Tier 3

Tier 3 match fields correspond to properties defined within nested structures.

Match Field	Description

`address_family`	The address family of the **Network Socket** object.
	Value type: `network-socket-address-family-enum`
	Examples
	`?match[address_family]=AF_APPLETALK`
	`?match[address_family]=AF_INET,AF_INET6`

external_id	An identifier present in any STIX object(s) **external_references** property. **Value type:** string **Examples** ?match[external_id]=CVE-2016-1234 ?match[external_id]=CWE-20,T1245
Hashes MD5 SHA-1 SHA-256 SHA-512 SHA3-256 SHA3-512 SSDEEP TLSH	The Hashing Algorithm open vocabulary (hash-algorithm-ov) is used in the **External Reference**, **Artifact**, **File**, **Alternate Data Stream**, **Windows PE Binary File**, **Windows PE Optional Header**, **Windows PE Section**, and **X.509 Certificate** objects, which each include a hashes property of type hashes (a set of key/value pairs). **Value type:** string **Examples** ?match[SHA-256]=35a01331e9ad96f751278b891b6ea09699806faedfa237d40513d92ad1b7100f ?match[MD5]=9e04af713d91d493ef3301a050a18b7a,53d780fc1453f56d6dff77a93a920794
integrity_level	The integrity level of the **Windows Process** object. **Value type:** windows-integrity-level-enum **Examples** ?match[integrity_level]=high ?match[integrity_level]=medium,high
pe_type	The type of **PE** binary object. **Value type:** windows-pebinary-type-ov **Examples** ?match[pe_type]=dll ?match[pe_type]=dll,exe
phase_name	The name of the phase in a kill chain as defined in the **kill_chain_phases** property of an Attack Pattern, Indicator, Infrastructure, Malware, or Tool object. **Value type:** string **Examples** ?match[phase_name]=reconnaissance ?match[phase_name]=pre%2Dattack,post%2Dattack
service_status	The current status of the **Windows Service** object. **Value type:** windows-service-status-enum **Examples** ?match[service_status]=SERVICE_STOPPED ?match[service_status]=SERVICE_RUNNING,SERVICE_START_PENDING

`service_type`	The type of the **Windows Service** object.
	Value type: `windows-service-type-enum`
	Examples
	`?match[service_type]=SERVICE_WIN32_OWN_PROCESS`
	`?match[service_type]=SERVICE_KERNEL_DRIVER,SERVICE_FILE_SYSTEM_DRIVER`

`socket_type`	The type of **Network Socket** object.
	Value type: `network-socket-type-enum`
	Examples
	`?match[socket_type]=SOCK_RAW`
	`?match[socket_type]=SOCK_STREAM,SOCK_SEQPACKET`

`source_name`	A source name present in any STIX object(s) **`external_references`** property.
	Value type: `string`
	Examples
	`?match[source_name]=cve`
	`?match[source_name]=capec,veris`

`start_type`	The start options of the **Windows Service** object.
	Value type: `windows-service-start-type-enum`
	Examples
	`?match[start_type]=SERVICE_DISABLED`
	`?match[start_type]=SERVICE_AUTO_START,SERVICE_BOOT_START`

`tlp`	The marking-definition identifier applied to object(s). This is a shorthand to objects specifically marked with a TLP marking. The only allowed values **MUST** are `white`, `green`, `amber`, and `red`. Specific IDs for each TLP color **MUST** be mapped as defined on the **TLP Marking Object Type** section in [STIX Version 2.1].
	Value type: `string`
	Examples
	`?match[tlp]=white`
	`?match[tlp]=white,green`

Relationships Match Field

The Relationships class consists of a `relationships-all` match field that matches against any property that ends in "`_ref`" or "`_refs`" (value type `identifier`). For example, the filter

```
?match[relationships-all]=indicator--3600ad1b-fff1-4c98-bcc9-4de3bc2e2ffb
```

will return all objects that reference the given indicator object.

STIX object properties relevant to the `relationships-all` match field, as well as their descriptions, are given in the table below.

Property	Description
analysis_sco_refs	Specifies the SCO captured during the analysis process of a **Malware Analysis** object.
bcc_refs	Specifies the mailboxes that are "BCC" recipients of an **Email Message** object.
belongs_to_ref	Specifies the user account that the **Email Address** object belongs to.
belongs_to_refs	Specifies one or more autonomous systems that the **IPv4 Address** or **IPv6 Address** object belongs to.
body_raw_ref	Specifies the contents of non-textual MIME parts of an **Email MIME Component Type** object.
cc_refs	Specifies the mailboxes that are "CC" recipients of an **Email Message** object.
child_refs	Specifies the other processes that were spawned by the **Process** object.
contains_refs	Specifies other files or directory objects contained in a **Directory** or **Archive File Extension** object. Specifies other SCOs contained in a **File** object.
content_ref	Specifies the content of a **File** object.
created_by_ref	Specifies the identity creator identifier applied to any STIX object(s).
creator_user_ref	Specifies the user account that created the **Process** or **Windows Registry Key** object.
dst_payload_ref	Specifies the bytes sent from the destination to source in a **Network Traffic** object.
dst_ref	Specifies the destination of a **Network Traffic** object.
encapsulated_by_ref	Specifies a network traffic object that encapsulate a **Network Traffic** object.
encapsulates_refs	Specifies other network traffic objects encapsulated by a **Network Traffic** object.

from_ref	Specifies the value of the "From" header of an **Email Message** object. The "From" field specifies the author of the message (i.e., the mailbox of the person or system responsible for the writing of the message).
host_vm_ref	Specifies the virtual machine (software) environment used by a **Malware Analysis** object.
image_ref	Specifies the executable binary that was executed as the process image by a **Process** object.
installed_software_refs	Specifies software used by a **Malware Analysis** object.
marking_ref	Specifies the marking definition that describes a **Granular Marking** type.
message_body_data_ref	Specifies the data contained in an **HTTP Request Extension** object.
object_marking_refs	Specifies the marking definition applied to any STIX object.
object_ref	Specifies the object that the **Language Content** object applies to.
object_refs	Specifies the objects referred to by a **Grouping**, **Note**, **Observed Data**, **Opinion** or **Report** object.
observed_data_refs	Specifies the raw cyber data for a **Sighting** object.
opened_connections_refs	Specifies the network connections opened by a **Process** object.
operating_system_ref	Specifies the operating system used for analysis in a **Malware Analysis** object.
operating_system_refs	Specifies the operating systems that a **Malware** object executes on.
parent_directory_ref	Specifies the parent directory of a **File** object.
parent_ref	Specifies the process that spawned a **Process** object.
raw_email_ref	Specifies the raw binary contents of an **Email Message** object.

resolves_to_refs	Specifies an IPv4 address, IPv6 address, or domain name that a **Domain Name** object resolves to. May also specify a MAC address that an **IPv4 Address** or **IPv6 Address** object resolves to.
sample_ref	Specifies a file, network traffic, or artifact object that the **Malware Analysis** object was performed against.
sample_refs	Specifies a file or artifact object associated with a **Malware** object.
sender_ref	The value of the "Sender" field of an **Email Message** object. The "Sender" field specifies the mailbox of the agent responsible for the actual transmission of the message.
service_dll_refs	Specifies the DLLs loaded by a **Windows Service Extension** object.
sighting_of_ref	Specifies the SDO referenced in a **Sighting** object.
source_ref	Specifies the source SDO or SCO contained in a **Relationship** object.
src_payload_ref	Specifies the bytes sent from the source to the destination in a **Network Traffic** object.
src_ref	Specifies the source of a **Network Traffic** object.
target_ref	Specifies the target SDO or SCO contained in a **Relationship** object.
to_refs	Specifies the mailboxes that are "To" recipients of an **Email Message** object.
where_sighted_refs	Specifies the identities or locations describing the entities that saw a **Sighting** object.

Calculation Match Field

The Calculation class defines match fields that require calculation, rather than a simple match.

Match Field	Description

`confidence-gte`	Returns STIX objects with **`confidence`** property values greater than or equal to a given value. A filter **SHOULD** contain only a single value. If multiple values are provided, the filter is equivalent to using only the smallest value. **Example** `?match[confidence-gte]=80`
`confidence-lte`	Returns STIX objects with **`confidence`** property values less than or equal to a given value. A filter **SHOULD** contain only a single value. If multiple values are provided, the filter is equivalent to using only the largest value. **Example** `?match[confidence-lte]=70`
`modified-gte`	Returns STIX objects that have a **`modified`** property that is on or after a specific timestamp. A filter **SHOULD** contain only a single timestamp. If multiple timestamps are provided, the filter is equivalent to using only the earliest timestamp. **Example** `?match[modified-gte]=2021-01-05T12:10:01.000Z`
`modified-lte`	Returns STIX objects that have a **`modified`** property that is on or before a specific timestamp. A filter **SHOULD** contain only a single timestamp. If multiple timestamps are provided, the filter is equivalent to using only the latest timestamp. **Example** `?match[modified-lte]=2021-06-27T00:00:00.000Z`
`number-gte`	Returns **Autonomous System** objects where the **`number`** property is greater than or equal to a given value. A filter **SHOULD** contain only a single value. If multiple values are provided, the filter is equivalent to using only the smallest value. **Example** `?match[number-gte]=15000`
`number-lte`	Returns **Autonomous System** objects where the **`number`** property is less than or equal to a given value. A filter **SHOULD** contain only a single value. If multiple values are provided, the filter is equivalent to using only the largest value. **Example** `?match[number-lte]=7500`

`src_port-gte`	Returns **Network Traffic** objects where the **`src_port`** property is greater than or equal to a given value. A filter **SHOULD** contain only a single value. If multiple values are provided, the filter is equivalent to using only the smallest value. **Example** `?match[src_port-gte]=5000`
`src_port-lte`	Returns **Network Traffic** objects where the **`src_port`** property is less than or equal to a given value. A filter **SHOULD** contain only a single value. If multiple values are provided, the filter is equivalent to using only the largest value. **Example** `?match[src_port-lte]=22000`
`dst_port-gte`	Returns **Network Traffic** objects where the **`dst_port`** property is greater than or equal to a given value. A filter **SHOULD** contain only a single value. If multiple values are provided, the filter is equivalent to using only the smallest value. **Example** `?match[dst_port-gte]=9500`
`dst_port-lte`	Returns **Network Traffic** objects where the **`dst_port`** property is less than or equal to a given value. A filter **SHOULD** contain only a single value. If multiple values are provided, the filter is equivalent to using only the largest value. **Example** `?match[dst_port-lte]=2000`
`valid_until-gte`	Returns **Indicator** objects that have a **`valid_until`** property that is on or after a specific timestamp. A filter **SHOULD** contain only a single timestamp. If multiple timestamps are provided, the filter is equivalent to using only the earliest timestamp. The **`valid_until`** property is optional and has specific interpretation in the STIX specification. For example, if the **`valid_until`** property is not present, the object is considered valid. Therefore, an indicator without a **`valid_until`** property will be returned. **Example** `?match[valid_until-gte]=2021-09-01T12:05:00.000Z`

`valid_from-lte`	Returns Indicator objects that have a **`valid_from`** property that is on or before a specific timestamp. A filter **SHOULD** contain only a single timestamp. If multiple timestamps are provided, the filter is equivalent to using only the earliest timestamp. **Example** `?match[valid_from-lte]=2020-05-25T01:01:01.000Z`

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Web	Master	OASIS
CTI	Mirror	OASIS
cti-cybox	Mirror	OASIS
cti-stix	Mirror	OASIS
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Appendix D. Revision History

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01	2022-03-01	Dez Beck Kartikey Desai Marlon Taylor	Initial version. Updated use cases to use TAXII 2.1, add new use cases, refreshed personas, and added advanced filtering.
02	2022-03-11	Dez Beck Kartikey Desai Marlon Taylor	TC Feedback. Updated examples, clarified language, and added additional test cases (HTTP Basic Authentication, Duplicate Filter Parameter).