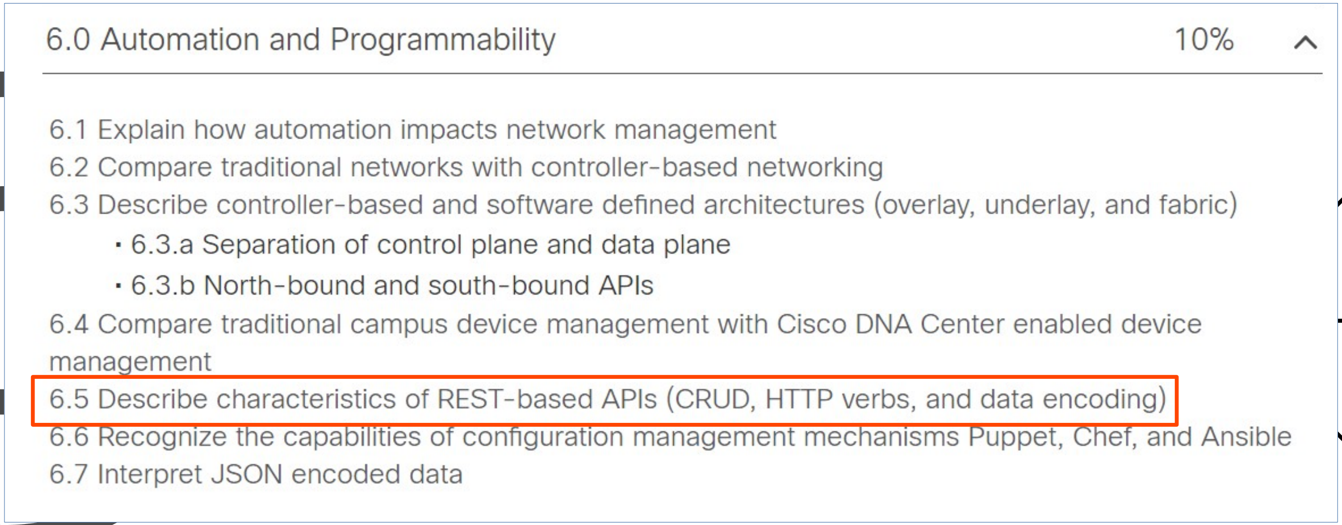
CCNA Day 61

REST APIs



6.0 Automation and Programmability 10%

6.1 Explain how automation impacts network management
6.2 Compare traditional networks with controller-based networking
6.3 Describe controller-based and software defined architectures (overlay, underlay, and fabric)
- 6.3.a Separation of control plane and data plane
- 6.3.b North-bound and south-bound APIs

6.4 Compare traditional campus device management with Cisco DNA Center enabled device management
6.5 Describe characteristics of REST-based APIs (CRUD, HTTP verbs, and data encoding)
6.6 Recognize the capabilities of configuration management mechanisms Puppet, Chef, and Ansible
6.7 Interpret JSON encoded data

Things we'll cover

- API Review
- CRUD operations and HTTP verbs
- REST APIs
- REST API Calls using Cisco DevNet

APIs

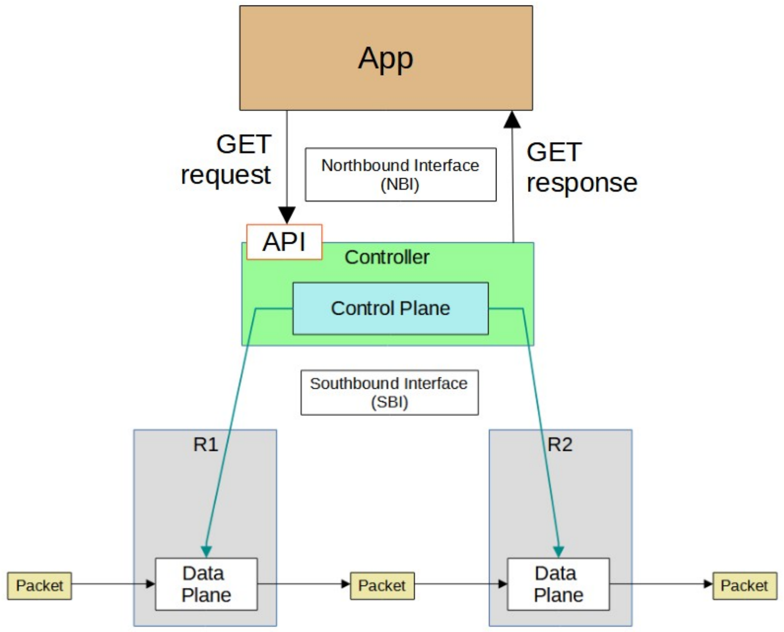
- An API (Application Programming Interface) is a software interface that allows two applications to communicate with each other.

- APIs are essential not just for network automation, but for all kinds of applications.

- In SDN architecture, APIs are used to communicate between apps and the SDN controller (via the NBI), and between the SDN controller and the network devices (via the SBI).

- The NBI typically uses REST APIs.

- NETCONF and RESTCONF are popular southbound APIs.



CRUD

- CRUD (Create, Read, Update, Delete) refers to the operations we perform using REST APIs.

- **Create** operations are used to create new variables and set their initial values.
  →ie. create variable “ip_address” and set the value to “10.1.1.1”.

- **Read** operations are used to retrieve the value of a variable.
  →ie. what is the value of variable “ip_address”?

- **Update** operations are used to change the value of a variable.
  →ie. change the value of variable “ip_address” to “10.2.3.4”.

- **Delete** operations are used to delete variables.
  →ie. delete variable “ip_address”.

- HTTP uses *verbs* (aka. *methods*) that map to these CRUD operations.

- REST APIs typically use HTTP.

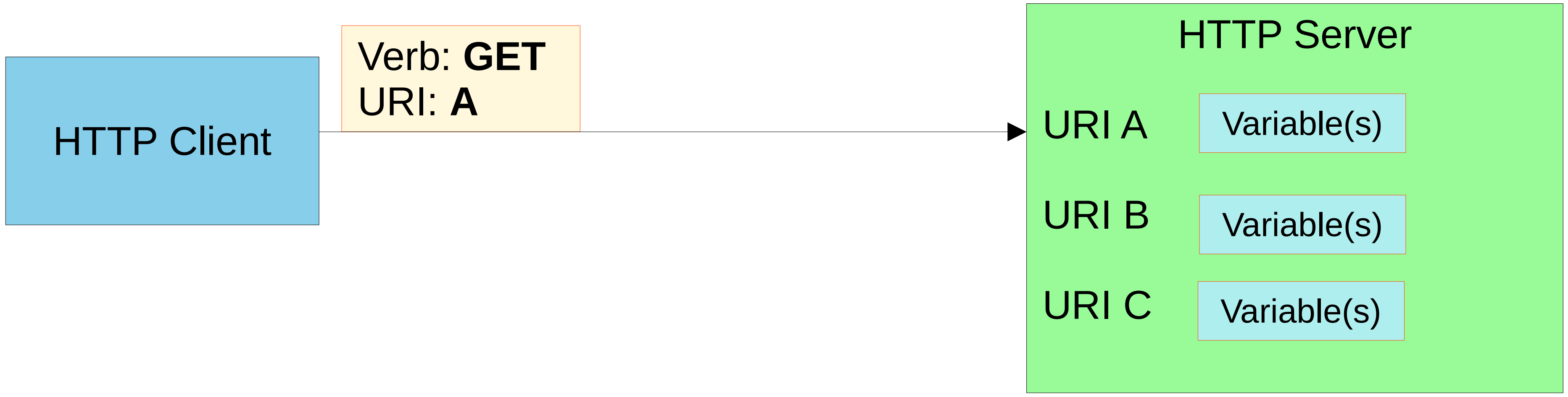
HTTP Verbs

Purpose	CRUD Operation	HTTP Verb
Create new variable	**Create**	**POST**
Retrieve value of variable	**Read**	**GET**
Change the value of variable	**Update**	**PUT, PATCH**
Delete variable	**Delete**	**DELETE**

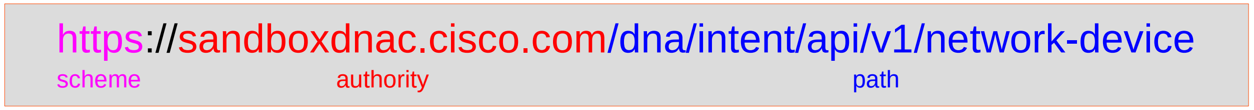
You can see the different HTTP verbs here: https://developer.mozilla.org/en-US/docs/Web/HTTP/Methods

HTTP Request

- When an HTTP client sends a request to an HTTP server, the HTTP header includes information like this:
  → An HTTP Verb (ie. GET)
  → A URI (Uniform Resource Identifier), indicating the resource it is trying to access.



- Here's an example of a URI (which we will use in the demonstration later):



https://sandboxdnac.cisco.com/dna/intent/api/v1/network-device
scheme
authority
path

HTTP Request

- The HTTP request can include additional headers which pass additional information to the server.
  →Check the list at https://developer.mozilla.org/en-US/docs/Web/HTTP/Headers

IP Header	TCP Header	Verb	URI	Additional Headers	Data

- An example would be an **Accept** header, which informs the server about the type(s) of data that can be sent back to the client.
  →ie. **`Accept: application/json`** or **`Accept: application/xml`**

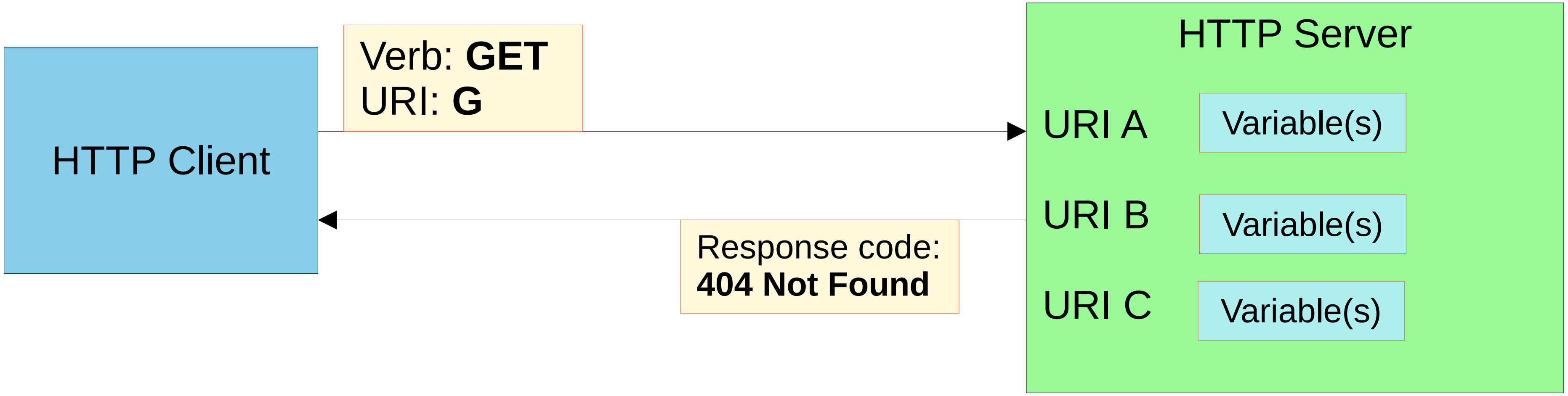
- You can also view standard HTTP header fields with some examples at https://en.wikipedia.org/wiki/List_of_HTTP_header_fields

- When a REST client makes an API call (request) to a REST server, it will send an HTTP request like the one above.
  *REST APIs don't *have* to use HTTP for communication, although HTTP is the most common choice.

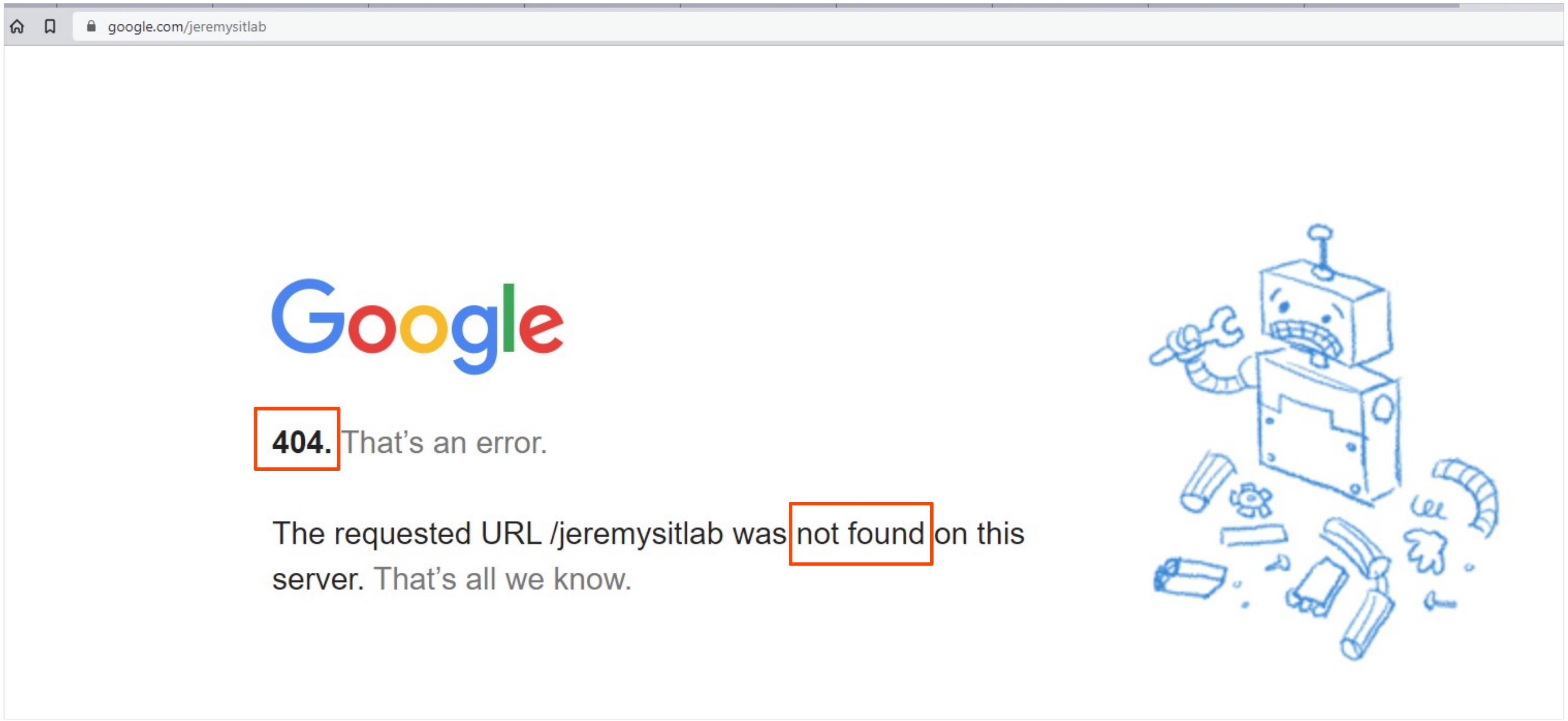
HTTP Response

- The server's response will include a status code indicating if the request succeeded or failed, as well as other details.

- The first digit indicates the class of the response:
  → **1xx** *informational* – the request was received, continuing process
  → **2xx** *successful* – the request was successfully received, understood, and accepted
  → **3xx** *redirection* – further action needs to be taken in order to complete the request
  → **4xx** *client error* – the request contains bad syntax or cannot be fulfilled



HTTP



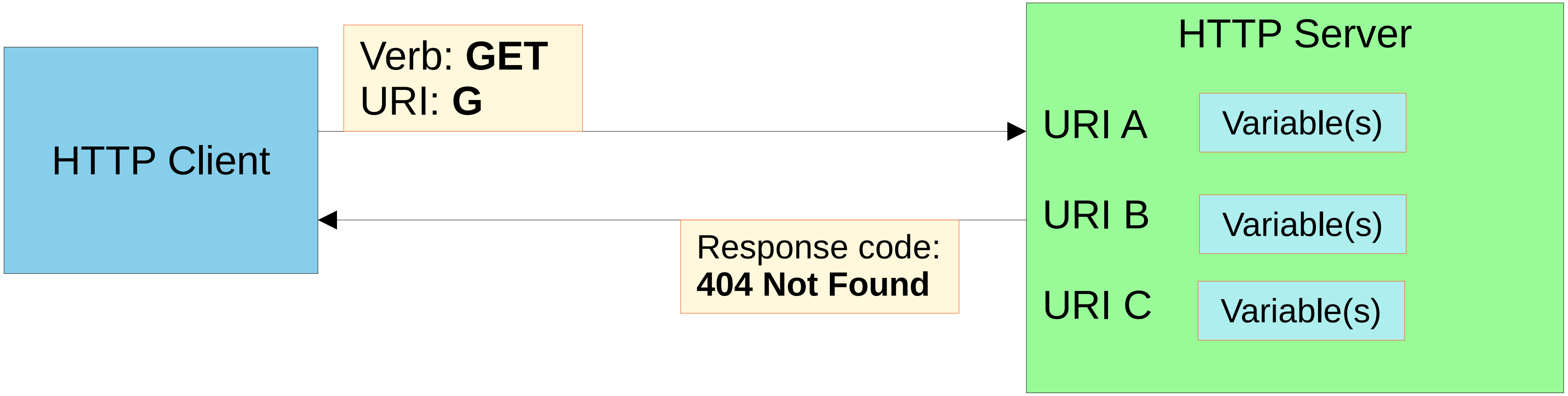
404. That's an error.

The requested URL /jeremysitlab was not found on this server. That's all we know.

HTTP Response

- The server's response will include a status code indicating if the request succeeded or failed, as well as other details.

- The first digit indicates the class of the response:
  → **1xx** *informational* – the request was received, continuing process
  → **2xx** *successful* – the request was successfully received, understood, and accepted
  → **3xx** *redirection* – further action needs to be taken in order to complete the request
  → **4xx** *client error* – the request contains bad syntax or cannot be fulfilled
  → **5xx** *server error* – the server failed to fulfill an apparently valid request



HTTP Response

Here are some examples of each HTTP Response class:

- **1xx** *Informational*
  →**102 Processing** indicates that the server has received the request and is processing it, but the response is not yet available.

- **2xx** *Successful*
  →**200 OK** indicates that the request succeeded.
  →**201 Created** indicates that the request succeeded and a new resource was created (ie. in response to POST)

- **3xx** *Redirection*
  →**301 Moved Permanently** indicates that the requested resource has been moved, and the server indicates its new location.

- **4xx** *Client Error*
  →**401 Unauthorized** means the client must authenticate to get a response.
  →**404 Not Found** means the requested resource was not found.

- **5xx** *Server Error*
  →**500 Internal Server Error** means the server encountered something unexpected that it doesn't know how to handle.

For more HTTP Response codes:https://developer.mozilla.org/en-US/docs/Web/HTTP/Status
For information about which Response codes to expect in response to each HTTP verb: https://www.restapitutorial.com/lessons/httpmethods.html

REST

- REST stands for Representational State Transfer.

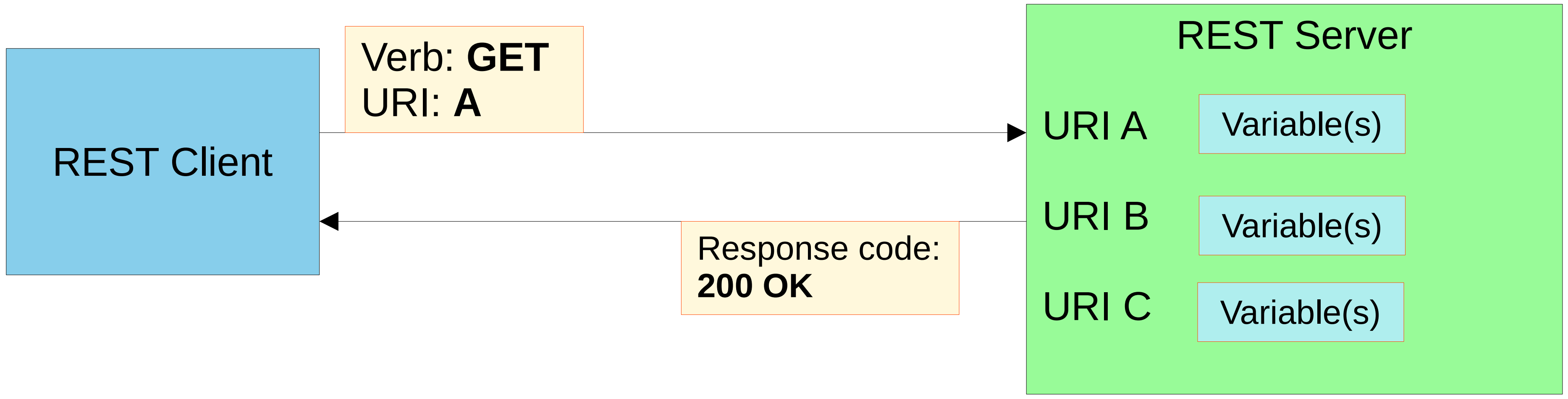
- **REST APIs** are also known as **REST-based APIs** or **RESTful APIs**.
  →REST isn't a specific API. Instead, it describes a set of rules about how the API should work.

- The six constraints of RESTful architecture are:
  → Uniform Interface
  → Client-server
  → Stateless
  → Cacheable or non-cacheable
  → Layered system
  → Code-on-demand (optional)

- For more details, check out: https://restfulapi.net/rest-architectural-constraints/

REST: Client-server

- **REST APIs** use a client-server architecture.
- The client uses API calls (HTTP requests) to access the resources on the server.
- The separation between the client and server means they can both change and evolve independently of each other.
  → When the client application changes or the server application changes, the interface between them must not break.



REST: Stateless

- **REST APIs** exchanges are stateless.

- This means that each API exchange is a separate event, independent of all past exchanges between the client and server.
  → The server does not store information about previous requests from the client to determine how it should respond to new requests.

- If authentication is required, this means that the client must authenticate with the server for each request it makes.

- TCP is an example of a stateful protocol.

- UDP is an example of a stateless protocol.

  *Although REST APIs use HTTP, which uses TCP (stateful) as its Layer 4 protocol, HTTP and REST APIs themselves aren’t stateful. The functions of each layer are separate!

REST: Cacheable or Non-Cacheable

- **REST APIs** must support caching of data.

- *Caching* refers to storing data for future use.
  →For example, your computer might cache many elements of a web page so that it doesn't have to retrieve the entire page every time you visit it.
  →This improves performance for the client and reduces the load on the server.

- Not all resources have to be cacheable, but cacheable resources MUST be declared as cacheable.

REST

- **REST** (Representational State Transfer) **APIs** (aka **REST-based APIs** or **RESTful APIs**) are APIs that follow the REST architecture.
  →REST isn't a specific API. Instead, it describes a set of rules about how the API should work.

- The six constraints of RESTful architecture are:
  → Uniform Interface
  → Client-server
  → Stateless
  → Cacheable or non-cacheable
  → Layered system
  → Code-on-demand (optional)

- For more details, check out: https://restfulapi.net/rest-architectural-constraints/

- For applications to communicate over a network, networking protocols must be used to facilitate those communications.
  →For REST APIs, HTTP(S) is the most common choice.

Remember the CRUD actions, HTTP client request verbs, HTTP server response codes, and the basic characteristics of REST APIs.

Cisco DevNet

- “Cisco DevNet is Cisco's developer program to help developers and IT professionals who want to write applications and develop integrations with Cisco products, platforms, and APIs.”

- DevNet offers lots of free resources such as courses, tutorials, labs, sandboxes, documentation, etc. to learn about automation and develop your skills.

- There is also a DevNet certification track that you can pursue if you’re interested in automation.

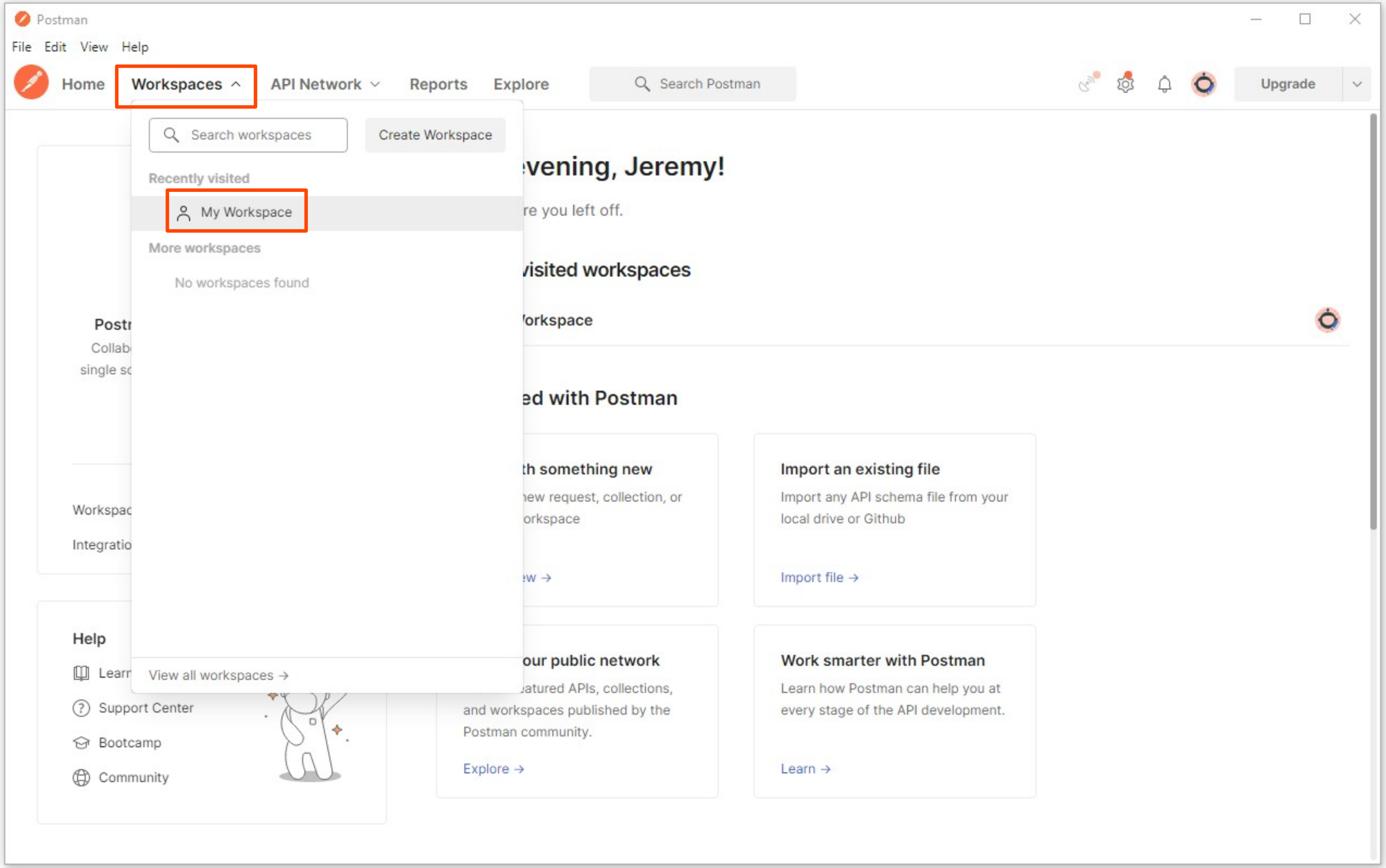
- We will use their Cisco **DNA Center** Sandbox to send a REST API call using **Postman**.
  →DNA Center is one of Cisco’s SDN controllers. We will cover it in more detail in the next video!
  →Postman is a platform for building and using APIs.

- To start:
  →Make an account on developer.cisco.com
  →Make an account on postman.com + download the desktop app (https://www.postman.com/downloads/).

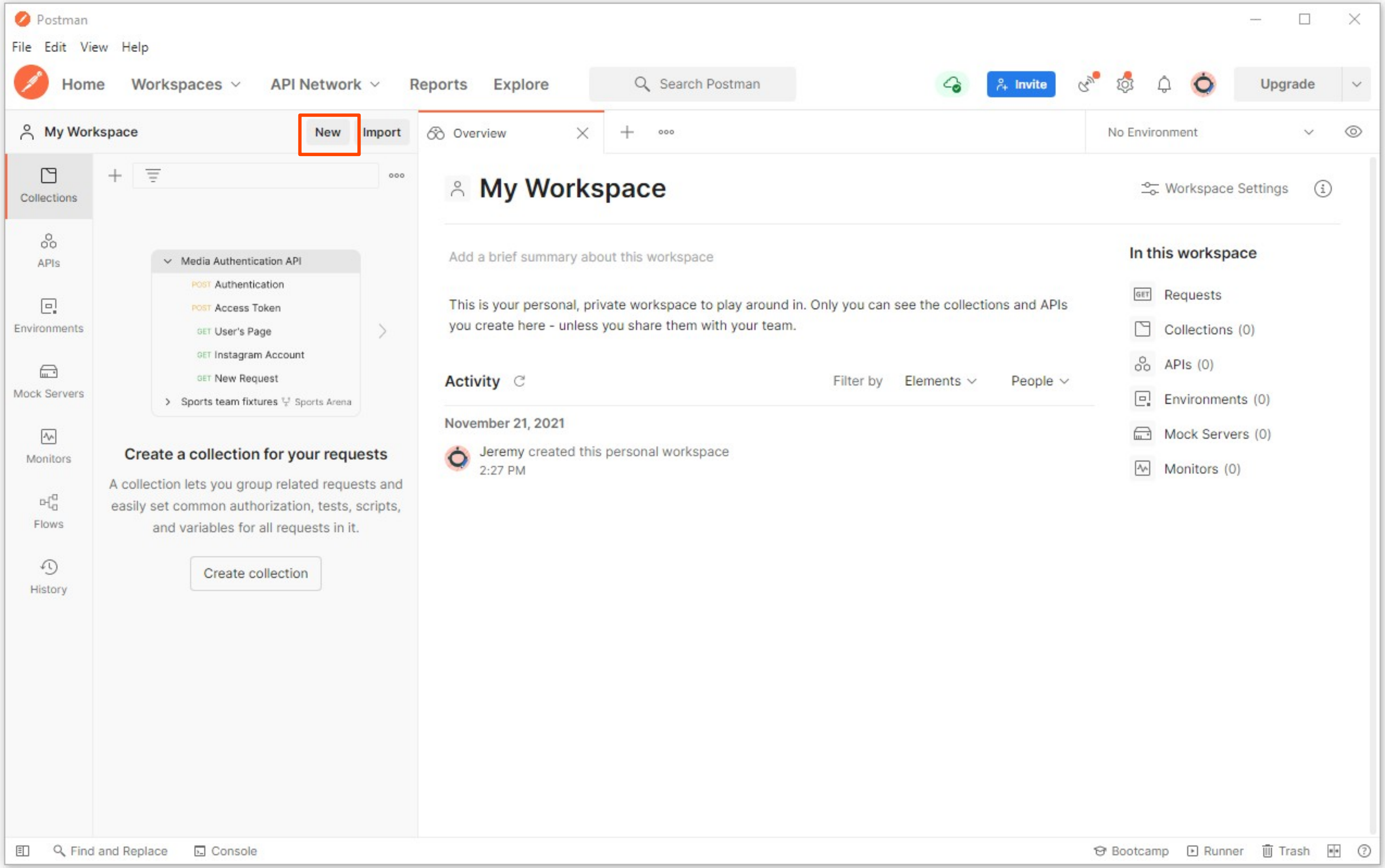
- I will be following this tutorial on DevNet: https://developer.cisco.com/docs/dna-center/#!getting-started

  *you don’t *have to* follow along, but I recommend you do!

API Calls to DNA Center



API Calls to DNA Center



My Workspace

Add a brief summary about this workspace

This is your personal, private workspace to play around in. Only you can see the collections and APIs you create here - unless you share them with your team.

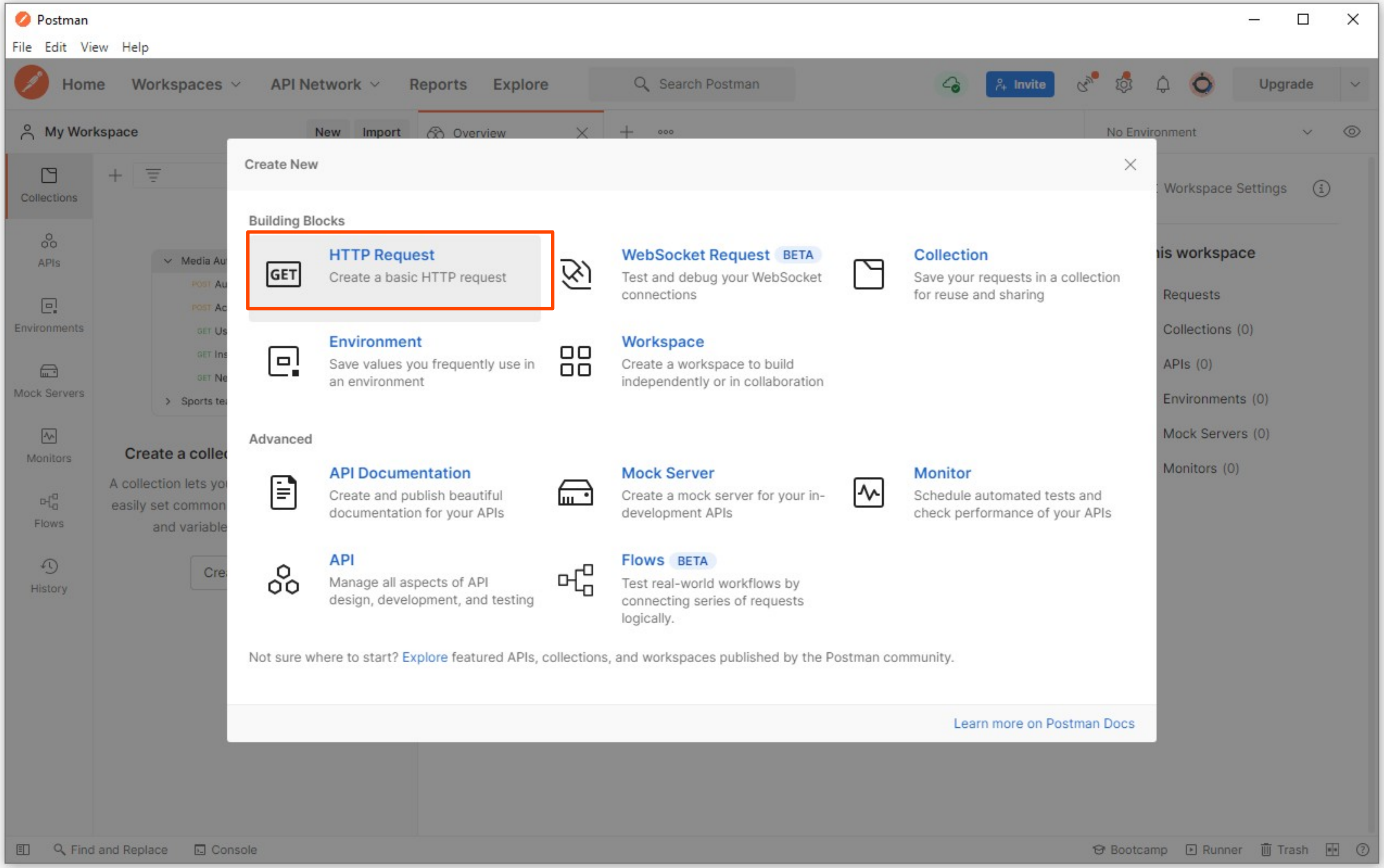
Create a collection for your requests

A collection lets you group related requests and easily set common authorization, tests, scripts, and variables for all requests in it.

November 21, 2021

Jeremy created this personal workspace
2:27 PM

API Calls to DNA Center



Create New

Building Blocks

HTTP Request
Create a basic HTTP request

WebSocket Request BETA
Test and debug your WebSocket connections

Collection
Save your requests in a collection for reuse and sharing

Environment
Save values you frequently use in an environment

Workspace
Create a workspace to build independently or in collaboration

Advanced

API Documentation
Create and publish beautiful documentation for your APIs

Mock Server
Create a mock server for your in-development APIs

Monitor
Schedule automated tests and check performance of your APIs

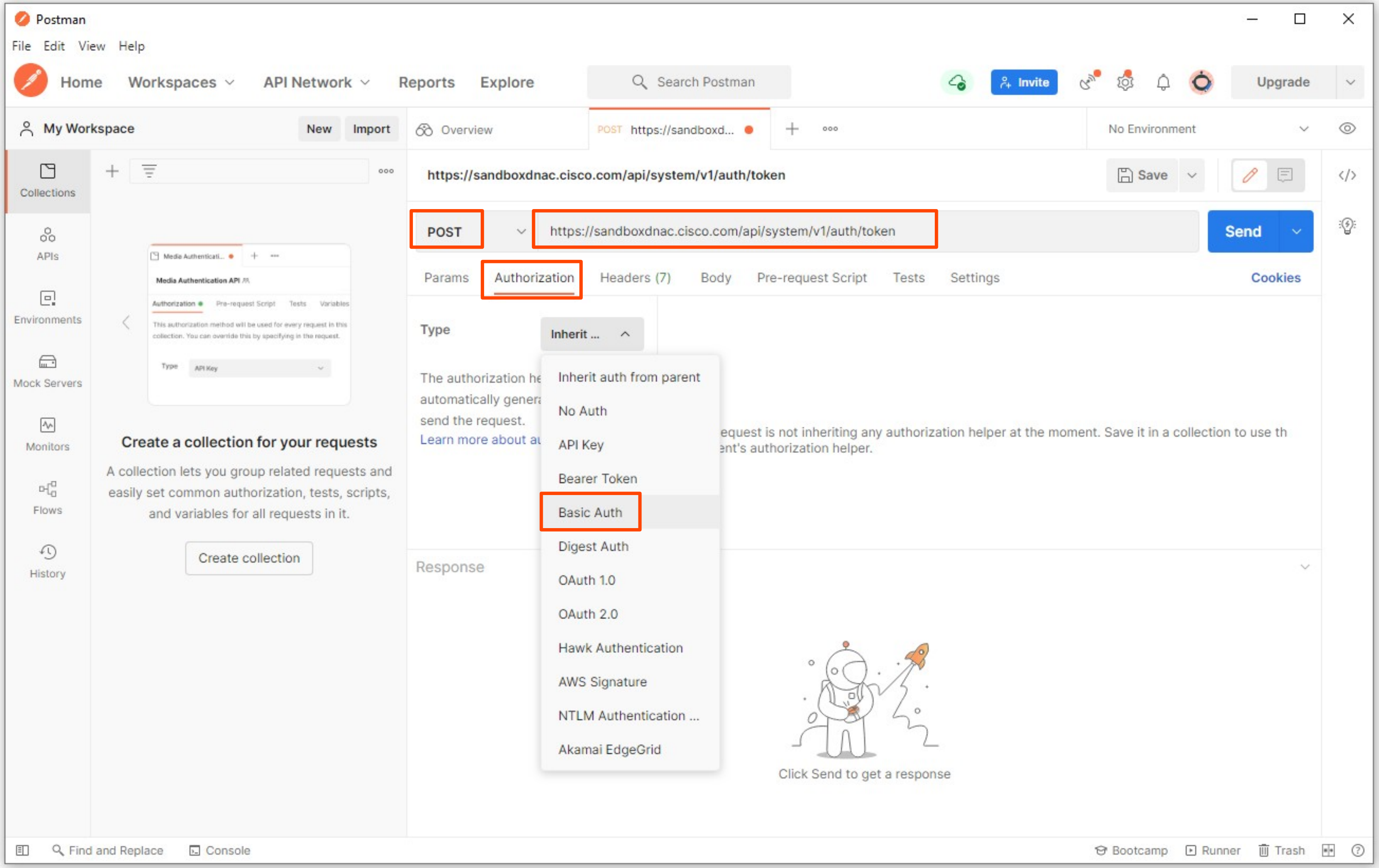
API
Manage all aspects of API design, development, and testing

Flows BETA
Test real-world workflows by connecting series of requests logically.

Not sure where to start? Explore featured APIs, collections, and workspaces published by the Postman community.

Learn more on Postman Docs

API Calls to DNA Center



https://sandboxdnac.cisco.com/api/system/v1/auth/token

POST https://sandboxdnac.cisco.com/api/system/v1/auth/token

Type: Inherit ...

- Inherit auth from parent
- No Auth
- API Key
- Bearer Token
- Basic Auth
- Digest Auth
- OAuth 1.0
- OAuth 2.0
- Hawk Authentication
- AWS Signature
- NTLM Authentication ...
- Akamai EdgeGrid

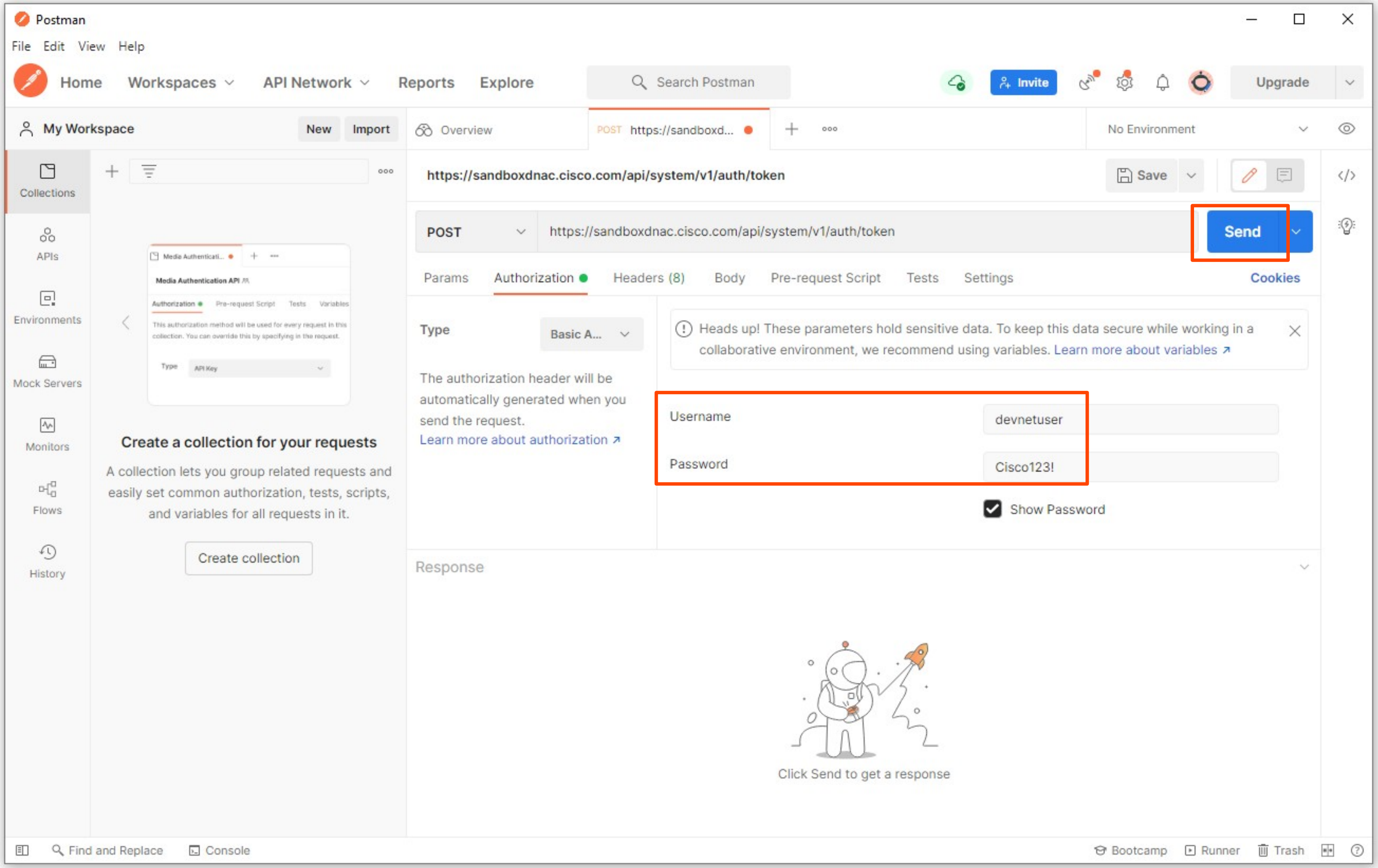
The authorization he automatically genera send the request. Learn more about au

equest is not inheriting any authorization helper at the moment. Save it in a collection to use th ent's authorization helper.

Create a collection for your requests

A collection lets you group related requests and easily set common authorization, tests, scripts, and variables for all requests in it.

API Calls to DNA Center



https://sandboxdnac.cisco.com/api/system/v1/auth/token

POST https://sandboxdnac.cisco.com/api/system/v1/auth/token

Params | Authorization ● | Headers (8) | Body | Pre-request Script | Tests | Settings

Type: Basic A...

The authorization header will be automatically generated when you send the request.
Learn more about authorization ↗

Heads up! These parameters hold sensitive data. To keep this data secure while working in a collaborative environment, we recommend using variables. Learn more about variables ↗

Username	devnetuser
Password	Cisco123!

[✓] Show Password

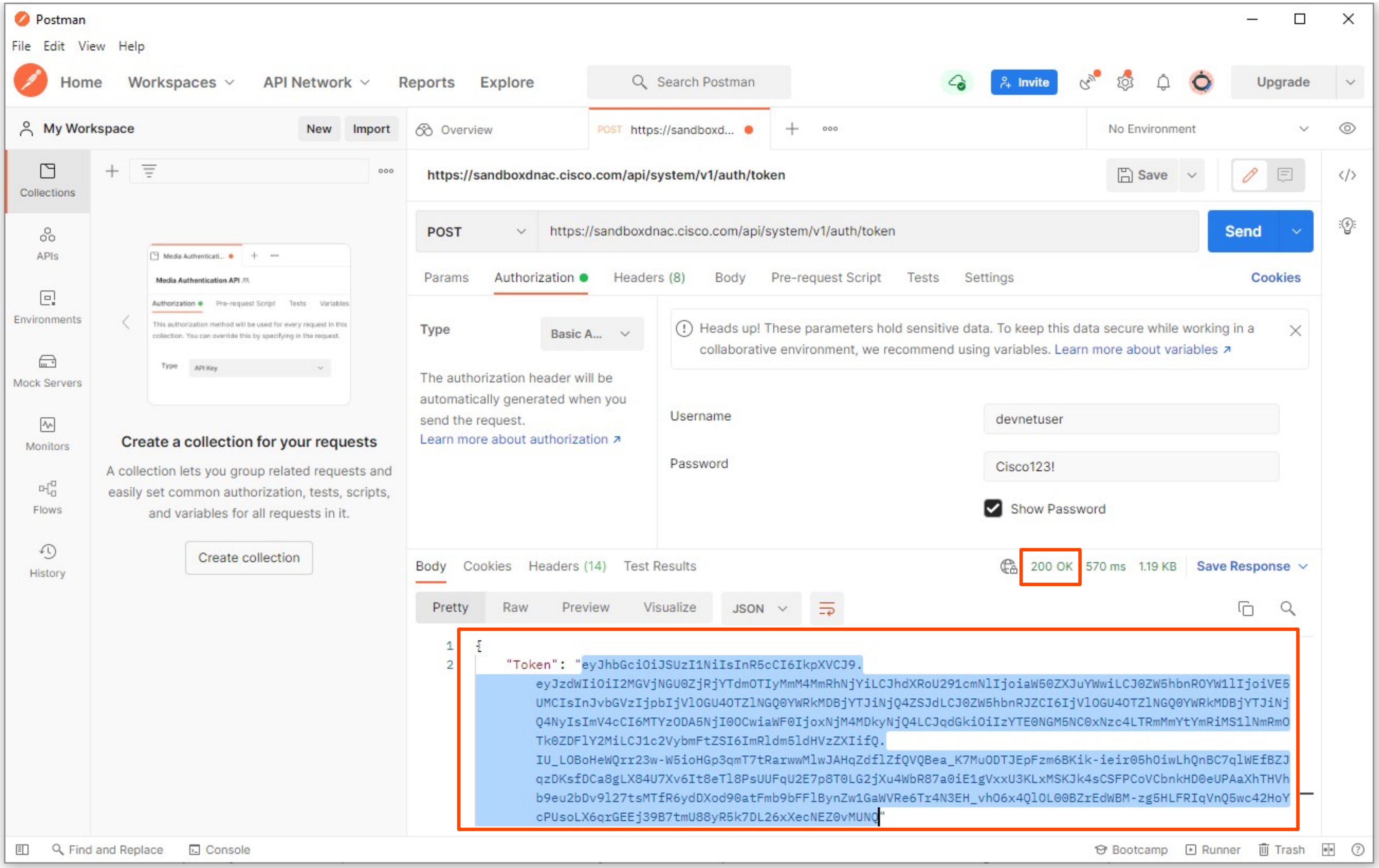
Create a collection for your requests

A collection lets you group related requests and easily set common authorization, tests, scripts, and variables for all requests in it.

Create collection

Click Send to get a response

API Calls to DNA Center



POST https://sandboxdnac.cisco.com/api/system/v1/auth/token

Authorization: Type Basic A...

The authorization header will be automatically generated when you send the request.

Heads up! These parameters hold sensitive data. To keep this data secure while working in a collaborative environment, we recommend using variables.

Username: devnetuser

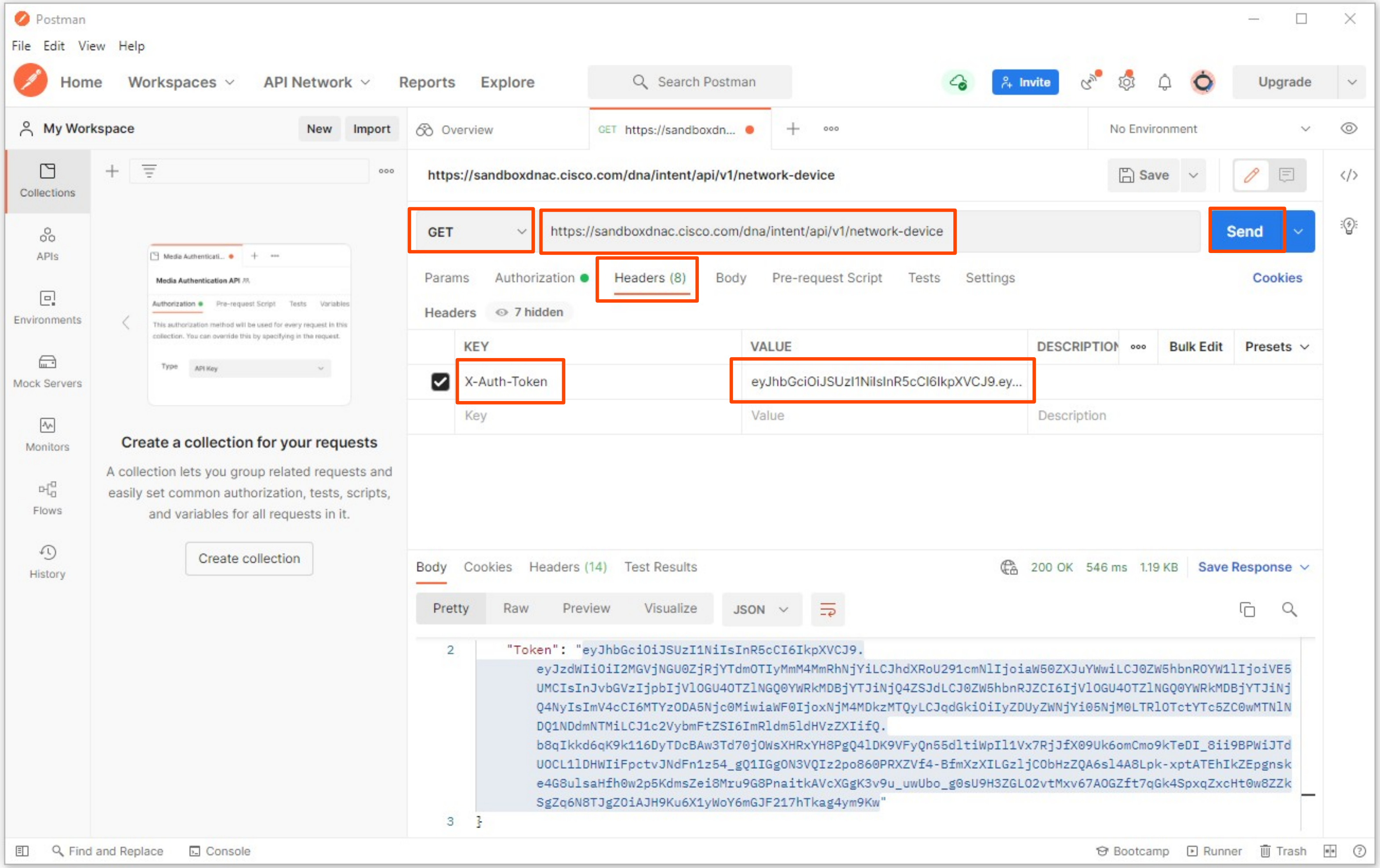
Password: Cisco123!

Show Password ✓

200 OK 570 ms 1.19 KB

```
{
    "Token": "eyJhbGciOiJSUzI1NiIsInR5cCI6IkpXVCJ9.
        eyJzdWIiOiI2MGVjNGU0ZjRjYTdmOTIyMmM4MmRhNjYiLCJhdXRoU291cmNlIjoiaW50ZXJuYWwiLCJ0ZW5hbnROYW1lIjoiVE5
        UMCIsInJvbGVzIjpbIjVlOGU4OTZlNGQ0YWRkMDBjYTJiNjQ4ZSJdLCJ0ZW5hbnRJZCI6IjVlOGU4OTZlNGQ0YWRkMDBjYTJiNj
        Q4NyIsImV4cCI6MTYzODA5NjI0OCwiaWF0IjoxNjM4MDkyNjQ4LCJqdGkiOiIzYTE0NGM5NC0xNzc4LTRmMmYtYmRiMS1lNmRmO
        Tk0ZDFlY2MiLCJ1c2VybmFtZSI6ImRldm5ldHVzZXIifQ.
        IU_LOBoHeWQrr23w-W5ioHGp3qmT7tRarwwMlwJAHqZdflZfQVQBea_K7MuODTJEpFzm6BKik-ieir05hOiwLhQnBC7qlWEfBZJ
        qzDKsfDCa8gLX84U7Xv6It8eTl8PsUUFqU2E7p8T0LG2jXu4WbR87a0iE1gVxxU3KLxMSKJk4sCSFPCoVCbnkHD0eUPAaXhTHVh
        b9eu2bDv9l27tsMTfR6ydDXod90atFmb9bFFlBynZw1GaWVRe6Tr4N3EH_vhO6x4QlOL00BZrEdWBM-zg5HLFRIqVnQ5wc42HoY
        cPUsoLX6qrGEEj39B7tmU88yR5k7DL26xXecNEZ0vMUNQ"
```

API Calls to DNA Center



GET https://sandboxdn...

https://sandboxdnac.cisco.com/dna/intent/api/v1/network-device

GET https://sandboxdnac.cisco.com/dna/intent/api/v1/network-device

Headers 7 hidden

	KEY	VALUE	DESCRIPTION
✓	X-Auth-Token	eyJhbGciOiJSUzI1NiIsInR5cCI6IkpXVCJ9.ey...	
	Key	Value	Description

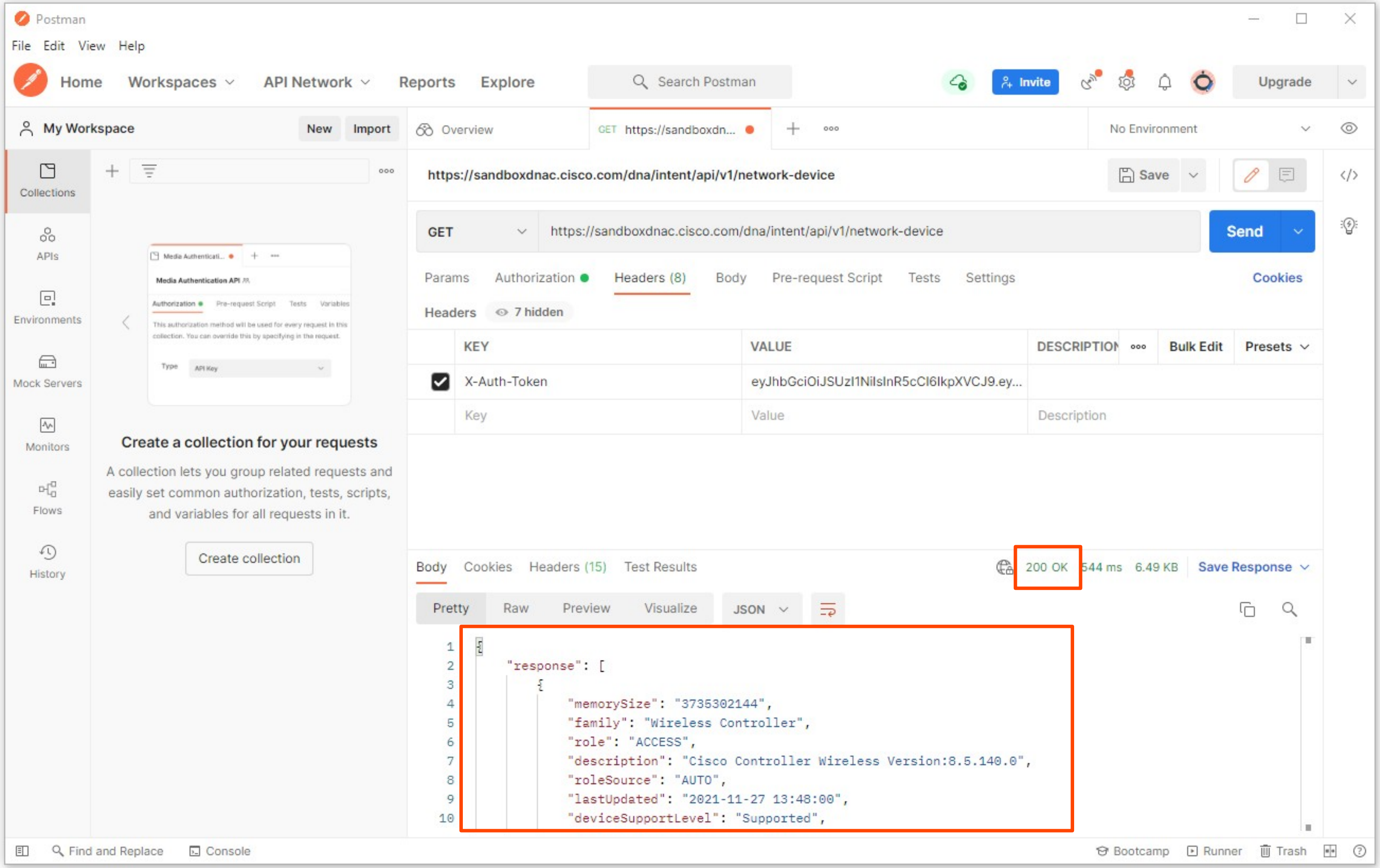
Create a collection for your requests

A collection lets you group related requests and easily set common authorization, tests, scripts, and variables for all requests in it.

200 OK 546 ms 1.19 KB

```
    "Token": "eyJhbGciOiJSUzI1NiIsInR5cCI6IkpXVCJ9.
        eyJzdWIiOiI2MGVjNGU0ZjRjYTdmOTIyMmM4MmRhNjYiLCJhdXRoU291cmNlIjoiaW50ZXJuYWwiLCJ0ZW5hbnROYW1lIjoiVE5
        UMCIsInJvbGVzIjpbIjVlOGU4OTZlNGQ0YWRkMDBjYTJiNjQ4ZSJdLCJ0ZW5hbnRJZCI6IjVlOGU4OTZlNGQ0YWRkMDBjYTJiNj
        Q4NyIsImV4cCI6MTYzODA5Njc0MiwiaWF0IjoxNjM4MDkzMTQyLCJqdGkiOiIyZDUyZWNjYi05NjM0LTRlOTctYTc5ZC0wMTNlN
        DQ1NDdmNTMiLCJ1c2VybmFtZSI6ImRldm5ldHVzZXIifQ.
        b8qIkkd6qK9k116DyTDcBAw3Td70jOWsXHRxYH8PgQ4lDK9VFyQn55dltiWpIl1Vx7RjJfX09Uk6omCmo9kTeDI_8ii9BPWiJTd
        UOCL1lDHWIiFpctvJNdFn1z54_gQ1IGgON3VQIz2po86OPRXZVf4-BfmXzXILGzljCObHzZQA6sl4A8Lpk-xptATEhIkZEpgnsk
        e4G8ulsaHfh0w2p5KdmsZei8Mru9G8PnaitkAVcXGgK3v9u_uwUbo_g0sU9H3ZGLO2vtMxv67AOGZft7qGk4SpxqZxcHt0w8ZZk
        SgZq6N8TJgZOiAJH9Ku6X1yWoY6mGJF217hTkag4ym9Kw"
}
```

API Calls to DNA Center



https://sandboxdnac.cisco.com/dna/intent/api/v1/network-device

GET https://sandboxdnac.cisco.com/dna/intent/api/v1/network-device

Headers 7 hidden

KEY	VALUE	DESCRIPTION
X-Auth-Token	eyJhbGciOiJSUzI1NiIsInR5cCI6IkpXVCJ9.ey...	
Key	Value	Description

200 OK 544 ms 6.49 KB

```
{
    "response": [
        {
            "memorySize": "3735302144",
            "family": "Wireless Controller",
            "role": "ACCESS",
            "description": "Cisco Controller Wireless Version:8.5.140.0",
            "roleSource": "AUTO",
            "lastUpdated": "2021-11-27 13:48:00",
            "deviceSupportLevel": "Supported",
```

API Calls to DNA Center

```
{
  "memorySize": "NA",
  "family": "Switches and Hubs",
  "role": "ACCESS",
  "roleSource": "AUTO",
  "lastUpdated": "2021-11-27 13:50:20",
  "deviceSupportLevel": "Supported",
  "softwareType": "IOS-XE",
  "softwareVersion": "17.3.3",
  "macAddress": "84:8a:8d:05:76:00",
  "collectionInterval": "Global Default",
  "inventoryStatusDetail": "<status><general
code=\"SUCCESS\"/></status>",
  "serialNumber": "FCW2220G09V",
  "lastUpdateTime": 1638021020343,
  "hostname": "leaf1.abc.inc",
  "tagCount": "0",
  "tunnelUdpPort": null,
  "uptimeSeconds": 2648950,
  "waasDeviceMode": null,
  "apManagerInterfaceIp": "",
  "bootDateTime": "2021-10-28 18:10:20",
  "collectionStatus": "Managed",
  "locationName": null,
  "managementIpAddress": "10.10.20.81",
  "platformId": "C9300-24U",
  "reachabilityFailureReason": "",
  "reachabilityStatus": "Reachable",
  "series": "Cisco Catalyst 9300 Series Switches",
  "snmpContact": "",
  "snmpLocation": "",
  "upTime": "29 days, 19:40:48.91",
  "apEthernetMacAddress": null,
  "associatedWlcIp": "",
  "errorCode": null,
  "errorDescription": null,
  "interfaceCount": "0",
  "lineCardCount": "0",
  "lineCardId": "",
  "managedAtleastOnce": true,
  "location": null,
  "type": "Cisco Catalyst 9300 Switch",
  "managementState": "Managed",
  "instanceUuid": "aa0a5258-3e6f-422f-9c4e-9c196db115ae",
  "instanceTenantId": "5e8e896e4d4add00ca2b6487",
  "id": "aa0a5258-3e6f-422f-9c4e-9c196db115ae"
}
```

Things we covered

- API Review
- CRUD operations and HTTP verbs
- REST APIs
- REST API Calls using Cisco DevNet

Remember the CRUD actions, HTTP client request verbs, HTTP server response codes, and the basic characteristics of REST APIs.

Quiz 1

What HTTP response code would you expect to receive if you tried to GET a resource that doesn’t exist on the server?

a) 403

b) 404

c) 500

d) 504

Quiz 2

Which of the following is NOT a constraint of RESTful architecture?

a) Client-Server

b) Cacheable

c) Stateful

d) Layered System

e) Uniform Interface

Quiz 3

Which category of HTTP response would you expect in response to a successful request?

a) 1xx

b) 2xx

c) 3xx

d) 4xx

e) 5xx

Quiz 4

HTTP verbs PUT and PATCH are equivalent to what CRUD operation?

a) C

b) R

c) U

d) D

Quiz 5

Which of the following would you expect to find as the *scheme* of a URI?

a) HTTPS

b) sandboxdnac.cisco.com

c) /dna/intent/api/v1/network-device

d) accept:application/xml