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APEX and OCI APIs

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Quickly - what is a REST API

Representational state transfer (REST)

- Defined in 2000 by Roy Fielding in his PhD assertation
  - Started in 1994 during the design of HTTP 1.1in the 'HTTP Object Model'

- "Web services that conform to the REST architectural style, called RESTful Web services, provide interoperability between computer systems on the internet. RESTful Web services allow the requesting systems to access and manipulate textual representations of Web resources by using a uniform and predefined set of stateless operations. Other kinds of Web services, such as SOAP Web services, expose their own arbitrary sets of operations."

- Uses mostly GET, PUT, POST and DELETE
  - Yes, yes, the full list is GET, HEAD, POST, PUT, PATCH, DELETE, CONNECT, OPTIONS and TRACE…
- Payload and answer usually in XML, HTTP or JSON

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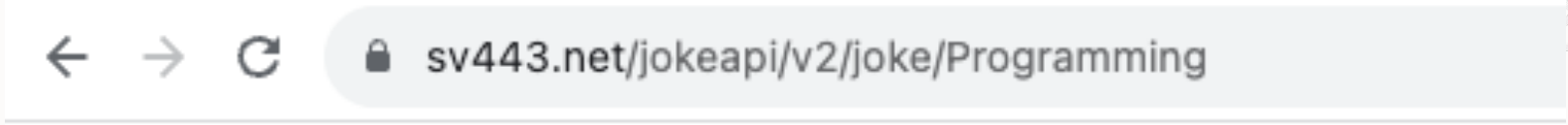
Calling a REST API from a Browser




```
{
    "error": false,
    "category": "Programming",
    "type": "twopart",
    "setup": "What is a dying programmer's last program?",
    "delivery": "Goodbye, world!",
    "flags": {
        "nsfw": false,
        "religious": false,
        "political": false,
        "racist": false,
        "sexist": false,
        "explicit": false
    },
    "id": 56,
    "safe": true,
    "lang": "en"
}
```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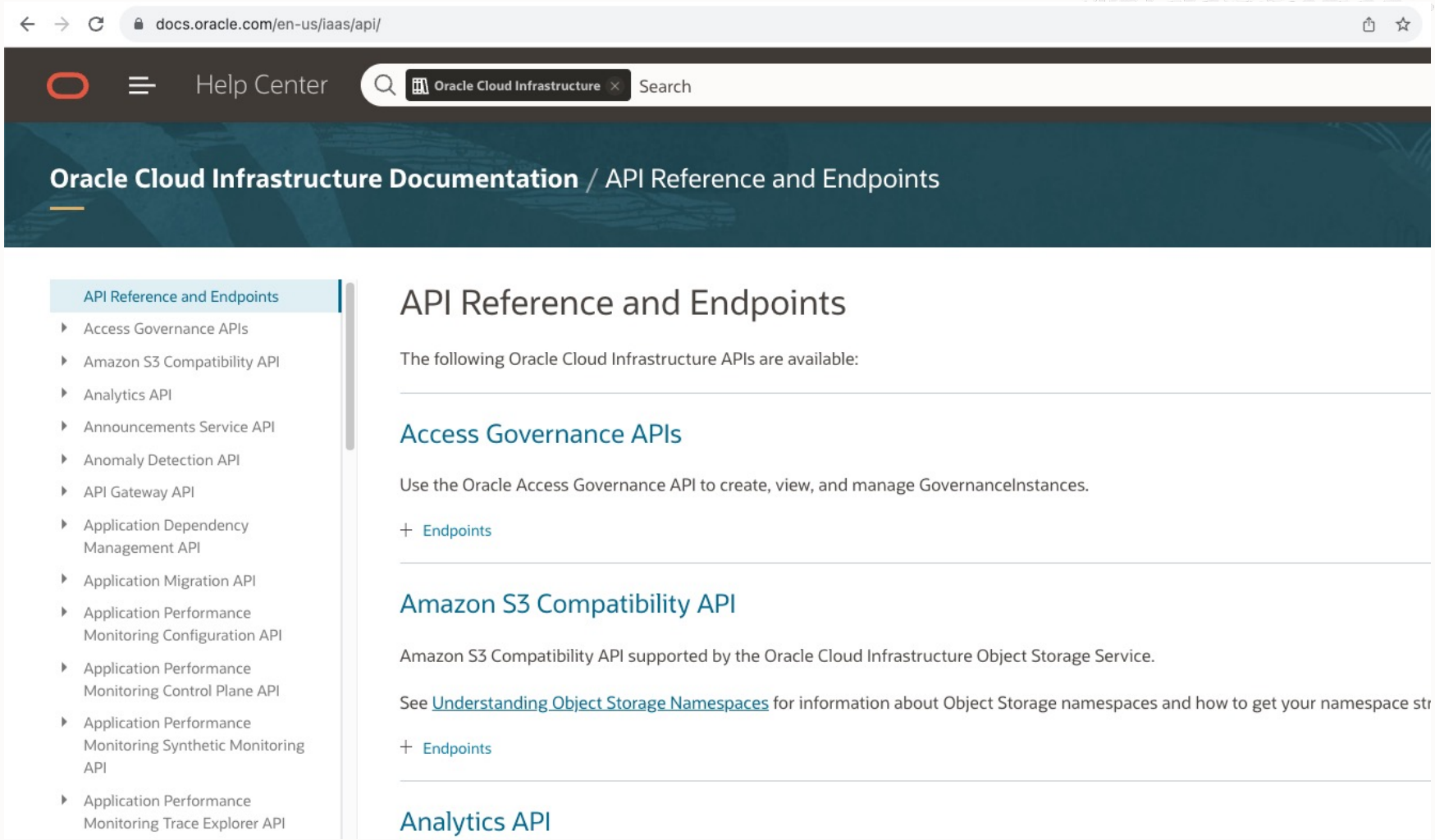
REST API Catalog for OCI



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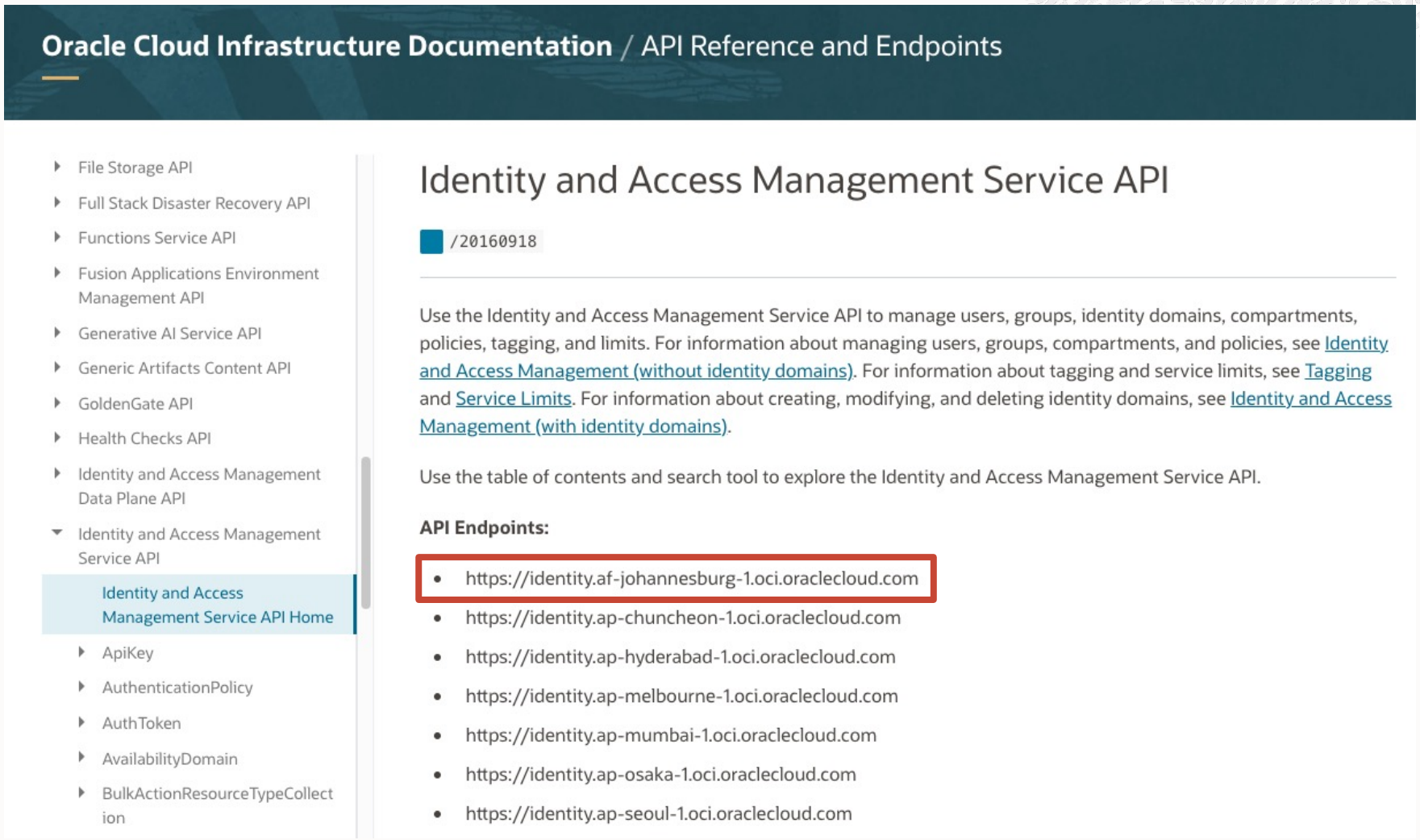
API Service Home URL



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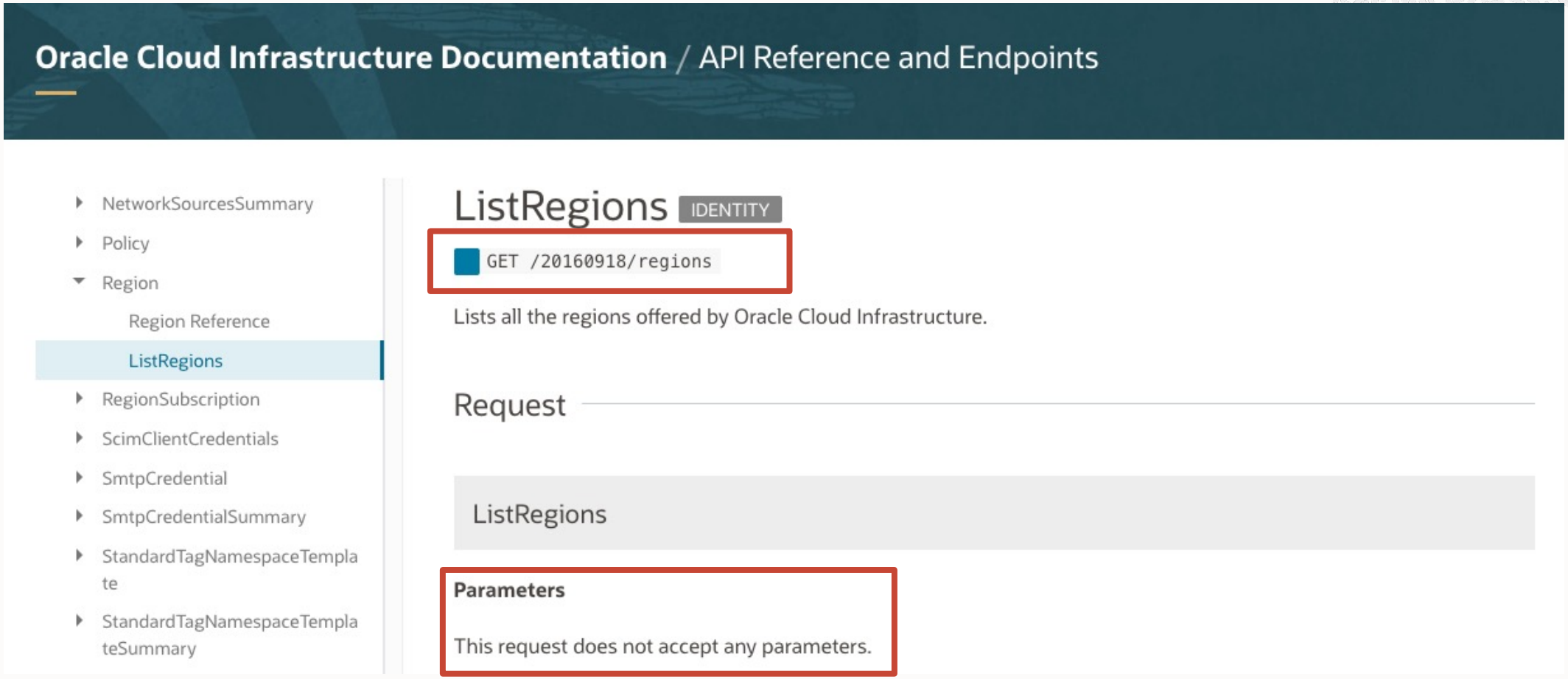
API Service Method



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Building a OCI REST call URL

- Generic layout
  - <API Endpoint>/<method>
- Additional requirements or options
  - Query parameters
  - Request Body (parameters in JSON format)

- Example without additional requirements
  - List all regions available in OCI
  - Can issue this to any endpoint
  - **https://identity.af-johannesburg-1.oci.oraclecloud.com/20160918/regions**

API endpoint Method

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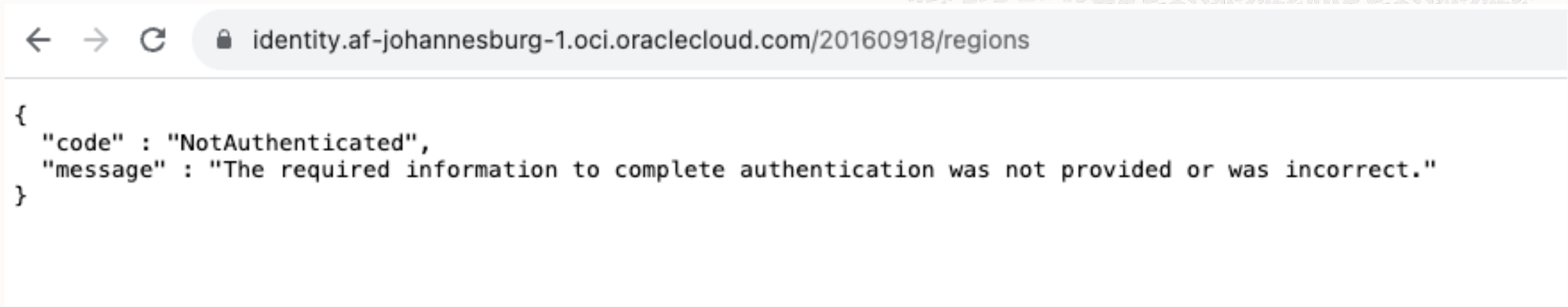
Authentication in OCI



Apparently, all OCI REST API calls require authentication

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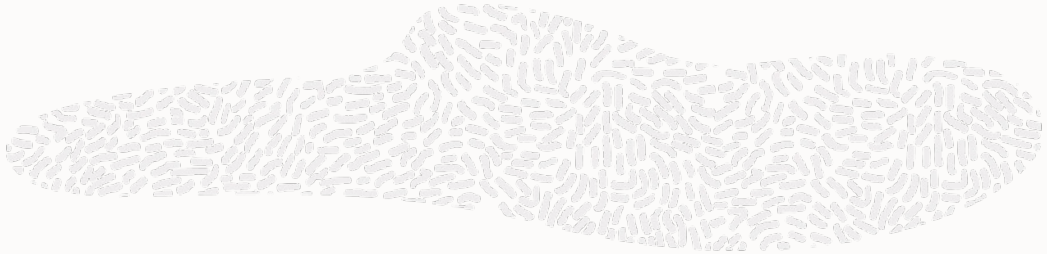
REST API Authentication in OCI



Based on the standards described in

https://tools.ietf.org/html/draft-cavage-http-signatures-08

Incomplete summary:

- Generate a public/private .pem key combination
  - This is not the same as the public/private key combination for SSH access !
- Register your public .pem key with Oracle OCI
  - Under your username that has the rights that you need
- Sign any request you have using your private .pem key before sending
  - Include the signature in the 'Authorization' header of the REST request to OCI
- OCI will validate your request based on the stored public .pem key
  - Make sure there is less than 5 minutes skew between the signer and the receiver

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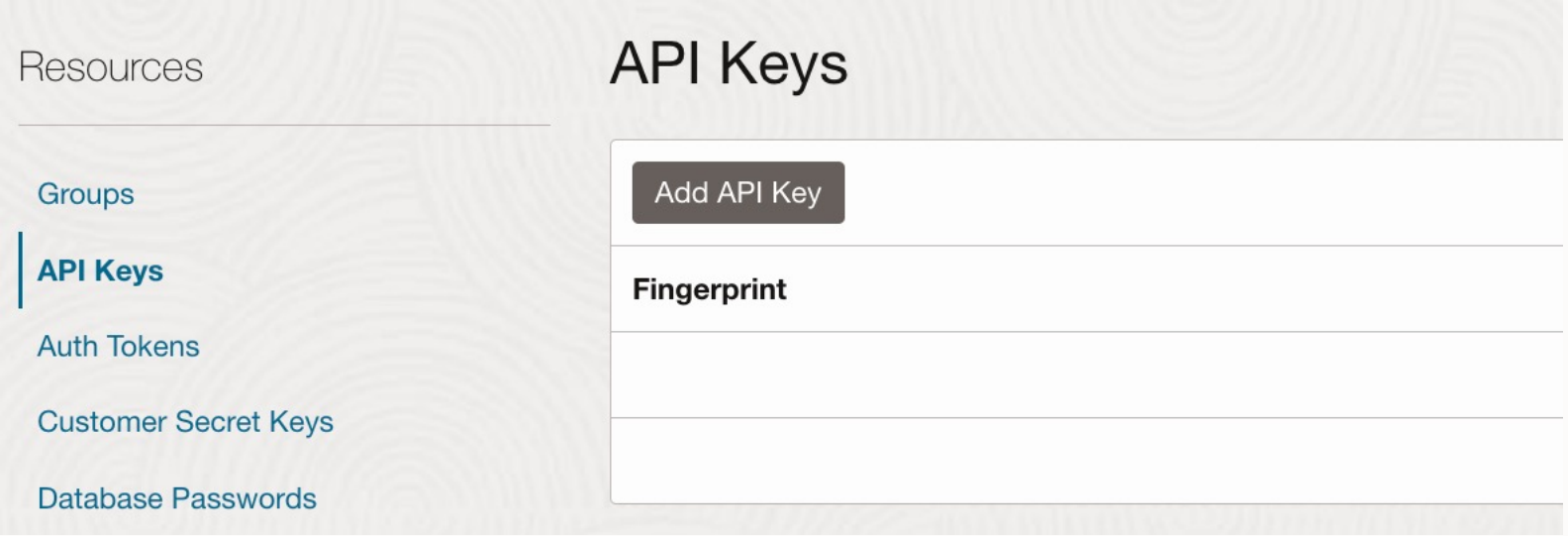
API key in OCI



API keys are used to authenticate REST calls to OCI

- Requires a PEM key
- Can be generated on the OS or during creation of the key

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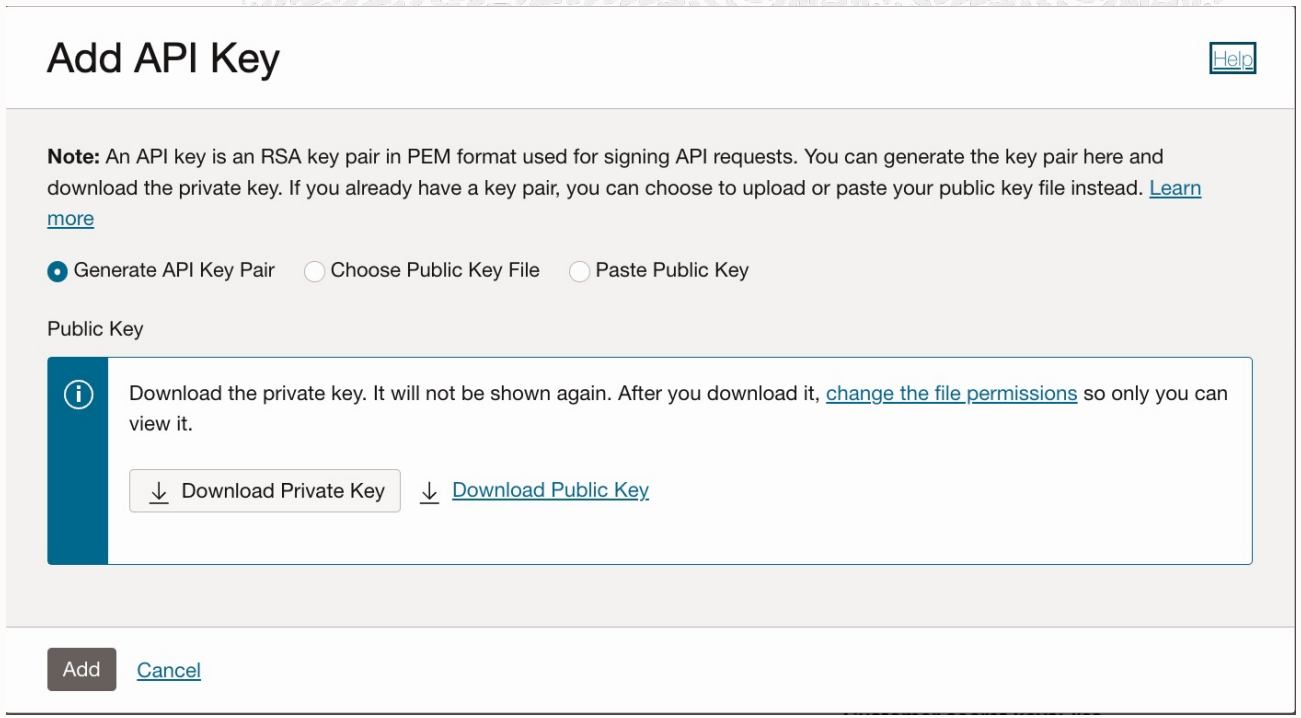
Create a new API Key entry in OCI

- Let OCI generate a key for you
  - Make sure you download the Private Key
  - Public key is not required
- Upload existing key
  - Pre-generate a key using tools
  - Can be generated by OpenSSL tools
  - See documentation for examples




```
$ openssl genrsa -out MyNewOciKey.pem 2048
```

```
$ openssl rsa -pubout -in MyNewOciKey.pem -out MyNewOciKey_public.pem
```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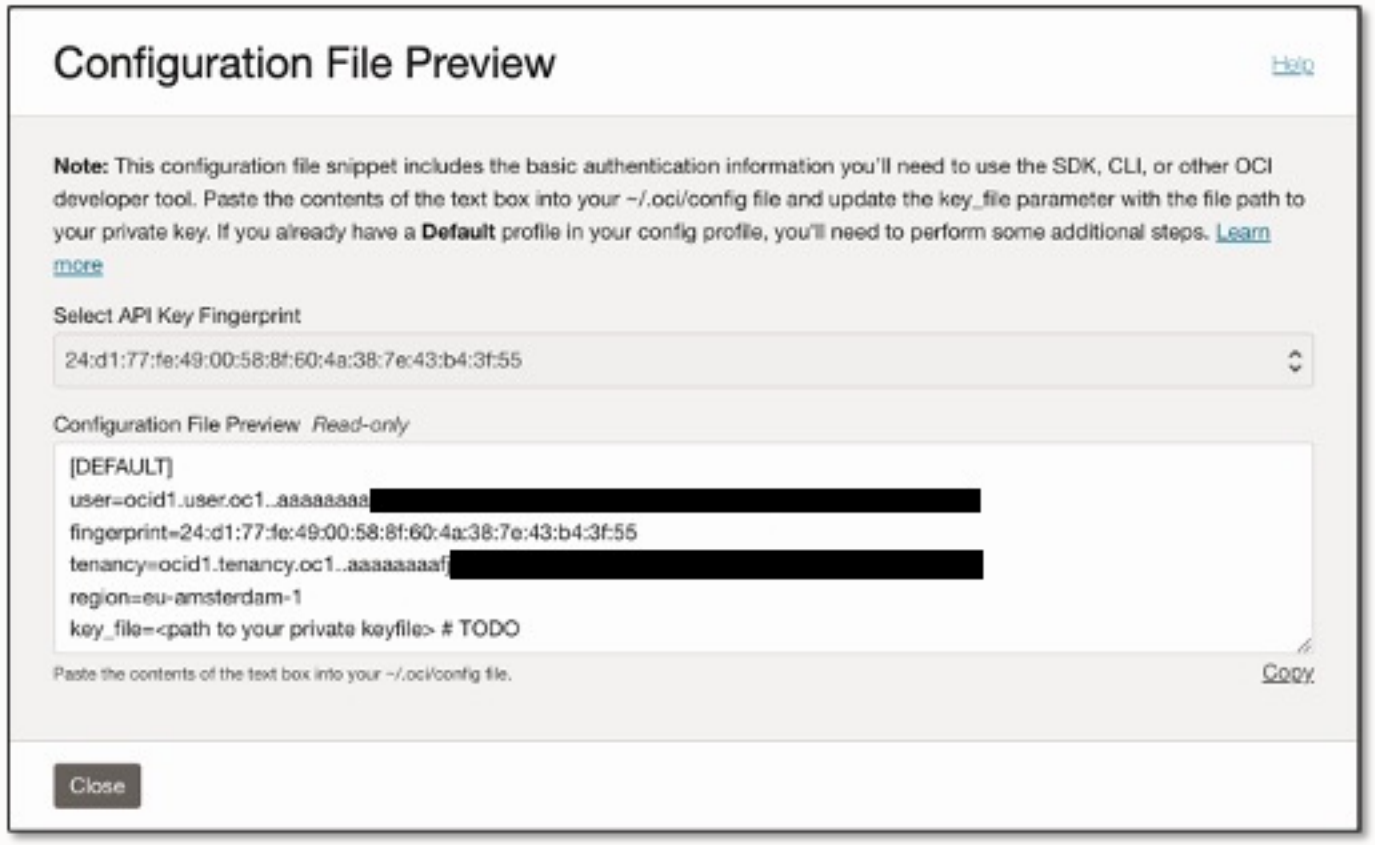
Retain information after creation



Private key is not enough for signing

- Need all information displayed in preview

Advice: Copy information and store it

- Same info can also be used for OCI CLI

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Use the API key for signing requests

- Every OCI REST API description has several examples
  - Java
  - Python
  - Go
  - Typescript
  - .NET
  - Ruby

- No Unix or PL/SQL

- When testing, make sure you enter your API details
  - Most examples expect a config file in the ~/.oci directory
  - Contents as indicated during the creation of the API key

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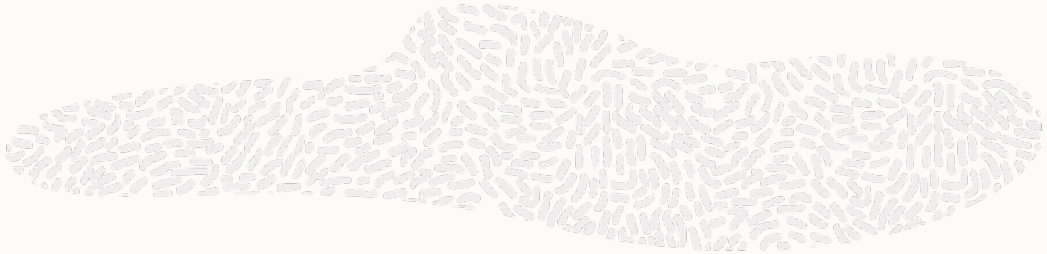
REST Calls from the database



- **Native APEX Rest sources**
  - Create security credential globally in the workspace
    - Or do this as part of the REST source creation
  - Create and use REST sources in the application

- **SQL and PL/SQL**
  - Signing using Java
  - Signing using APEX packages
  - Signing using DBMS_CLOUD in Autonomous Database

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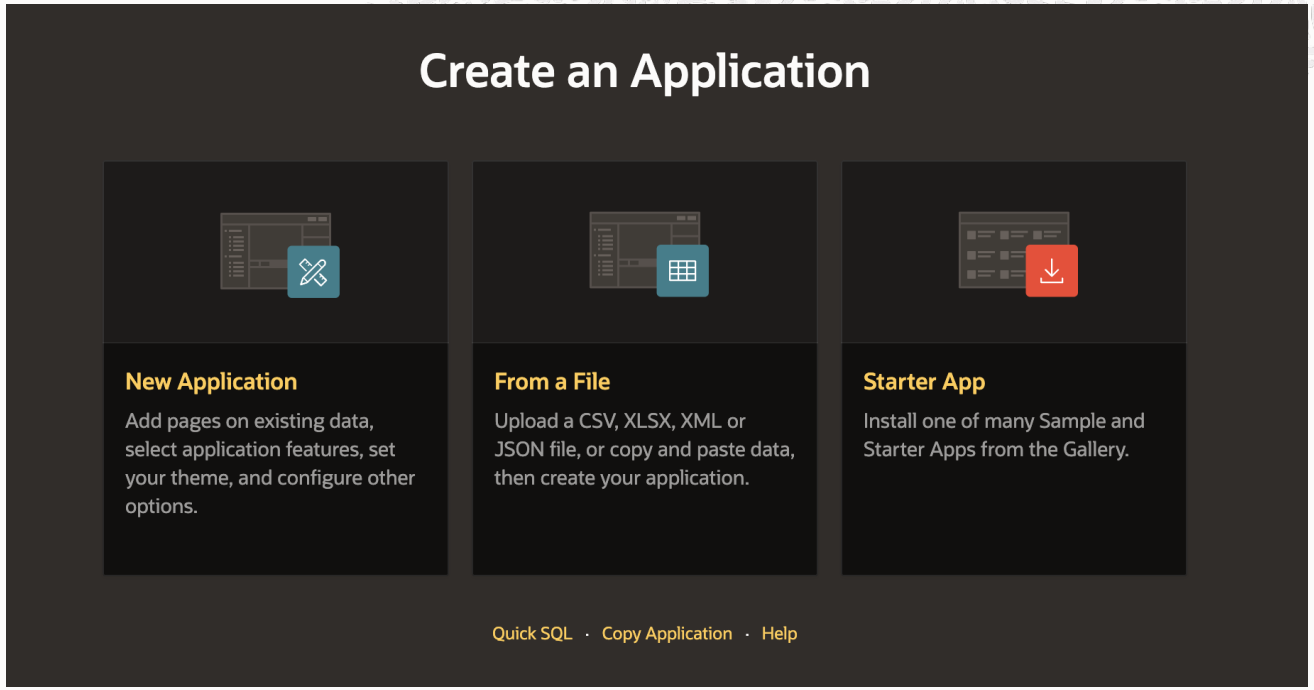
Native APEX REST sources

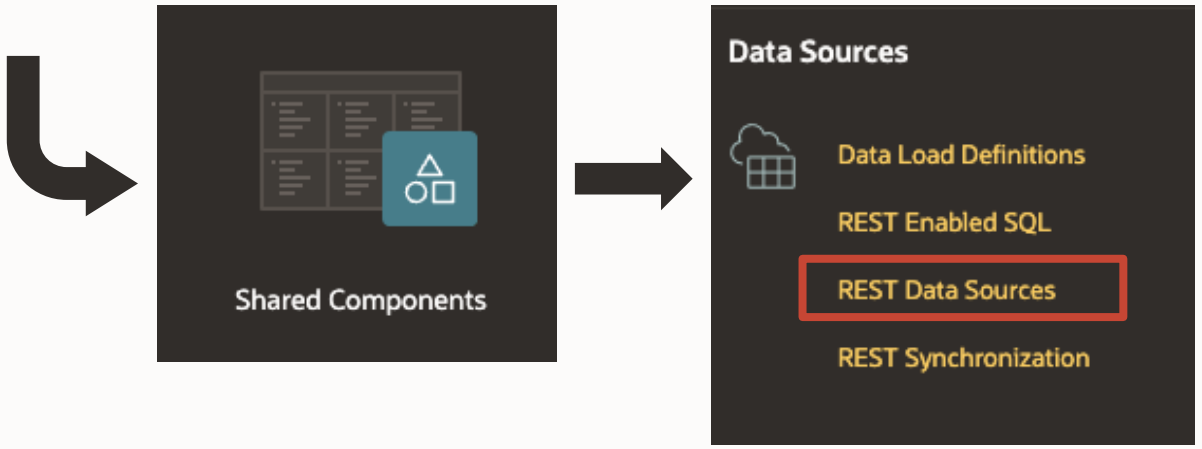
Create a new application workspace

Navigate to your new application



Select Shared Components

Choose for Rest Data Sources



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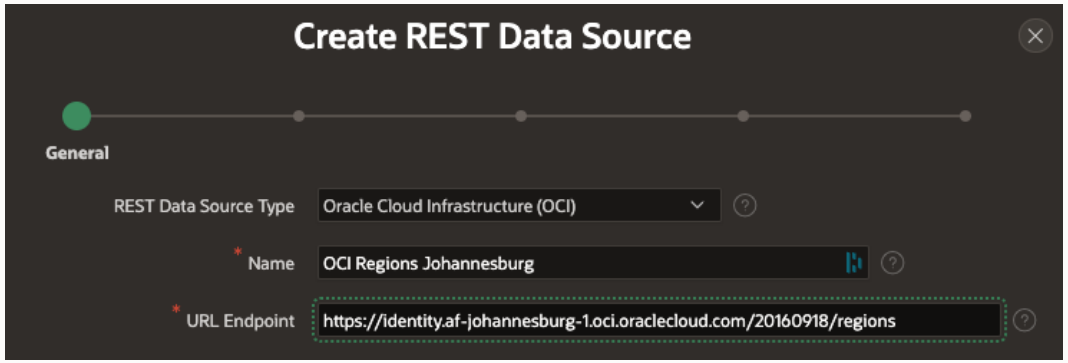
APEX Data Source Wizard | Step 1: Create a new Data Source

Creating a new credential starts a wizard

- Create a new REST Data Source from scratch

Step 1

- Data Source type = Oracle Cloud Infrastructure (OCI)
- Name
  - Give your REST API Endpoint a name
  - Example: OCI Regions Johannesburg
- URL Endpoint
  - The API Endpoint and method as described in the documentation
  - Example: https://identity.af-johannesburg-1.oci.oraclecloud.com/20160918/regions



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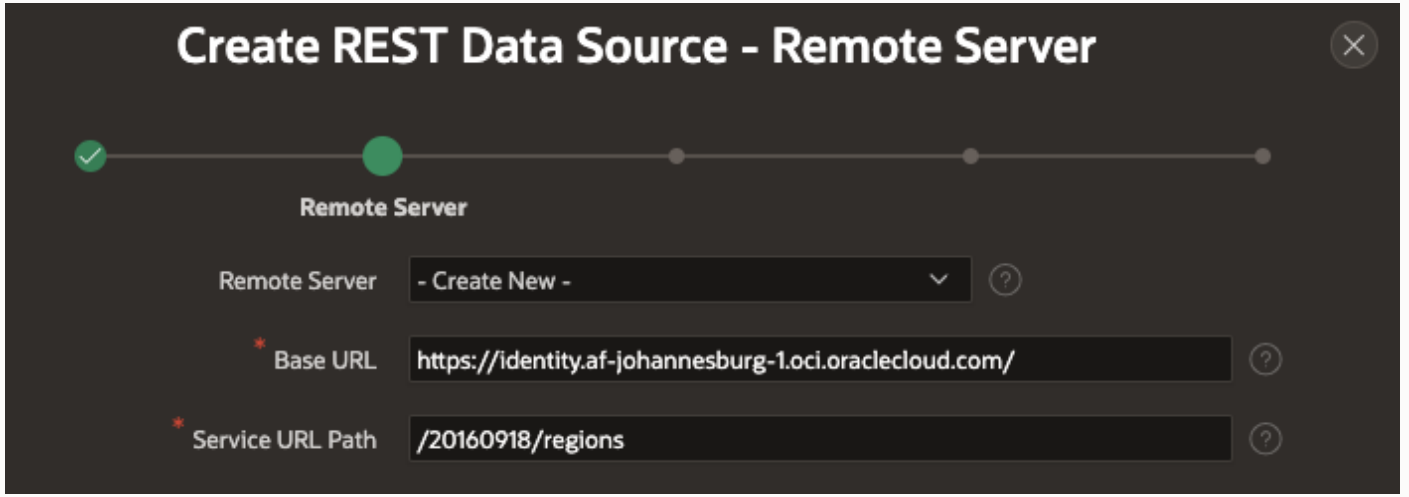
APEX Data Source Wizard | Step 2: Create a new Remote Server

APEX Wizard automatically detects the BASE URL or API Endpoint

BASE URL is stored as separate entity

- In case the BASE URL changes, all Data Sources can be changed in one step

Keep the values and press Next to continue



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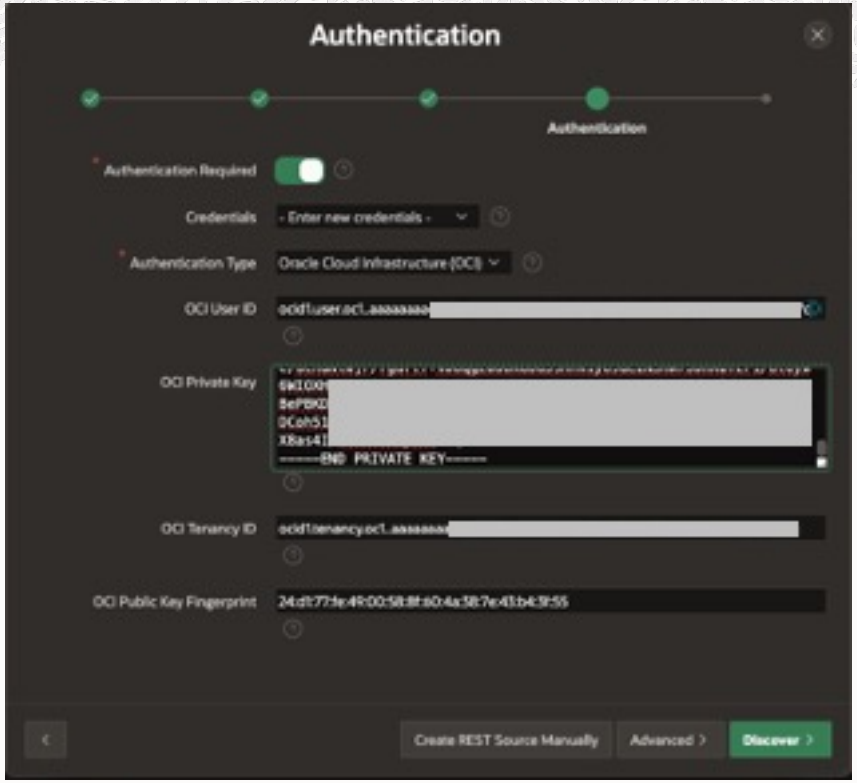
APEX Data Source Wizard | Step 3: Authentication

- We know that authentication is required in OCI
- We need to create new credentials
- Authentication type is Oracle Cloud Infrastructure



This displays additional fields

- OCI UserId
- OCI Private Key
- OCI Tenancy ID
- OCI Public Key Fingerprint

Fill in the fields with the values we learned when creating a new API key in OCI for our user

- Hint: Open the Privat Key file and copy/paste the entire contents in the OCI Private Key field
- The rest of the fields are available in the cut-and-paste we did when creating a new API key

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APEX Data Source Wizard | Step 4: Preview

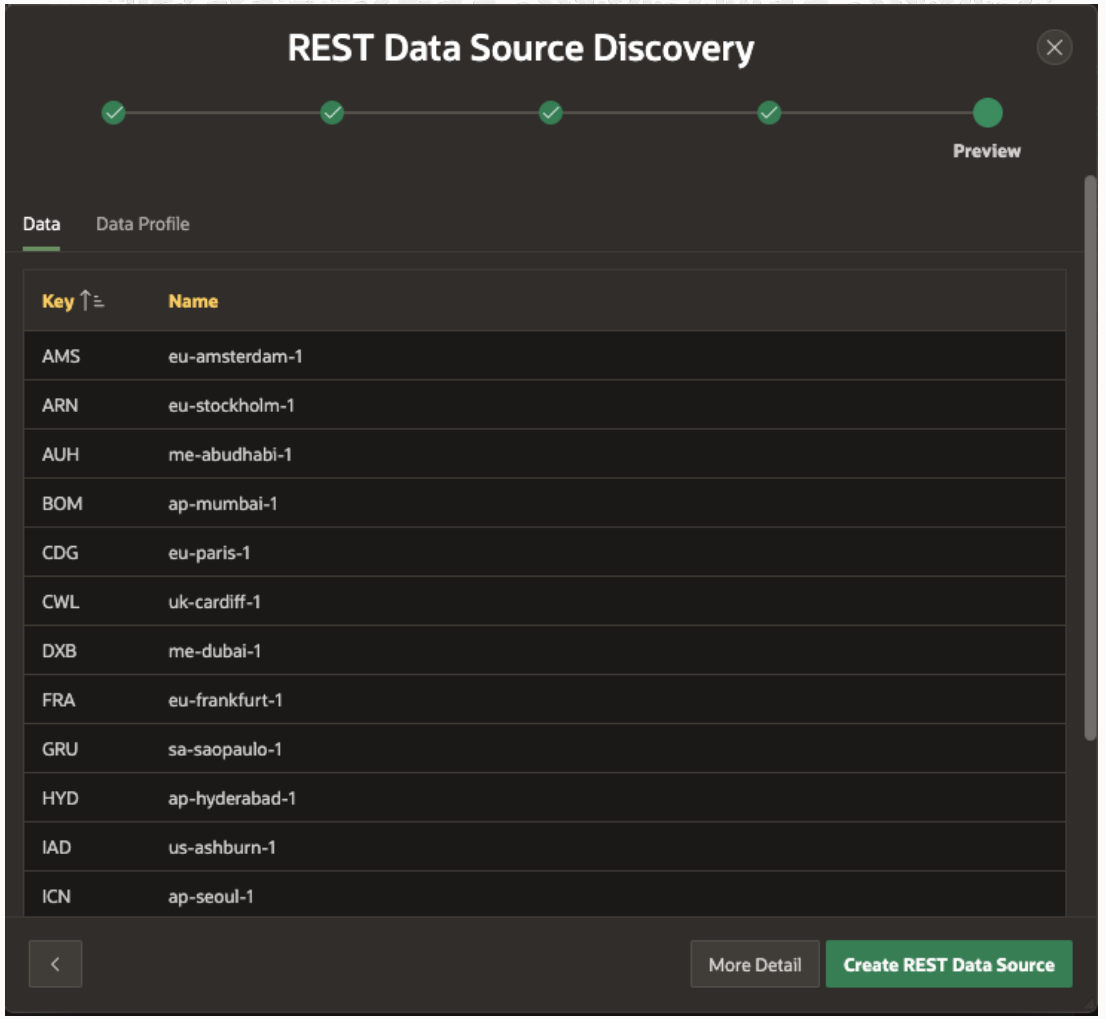
After entering the required details in the Authentication screen, click Discover to check if the REST API URL and Authentication information is correct.

APEX will now retrieve the information from the REST API specified.

If all went well, there should be a list of OCI Endpoint Keys and Names on the screen.

We can continue to create the REST Data Source

If the list is not visible, check for typos in the API URL or the Authentication settings.



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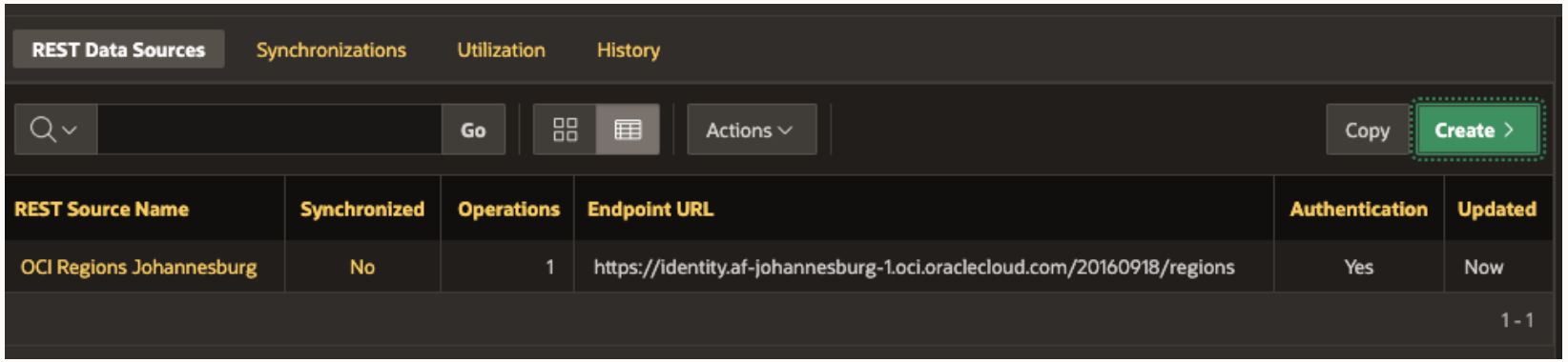
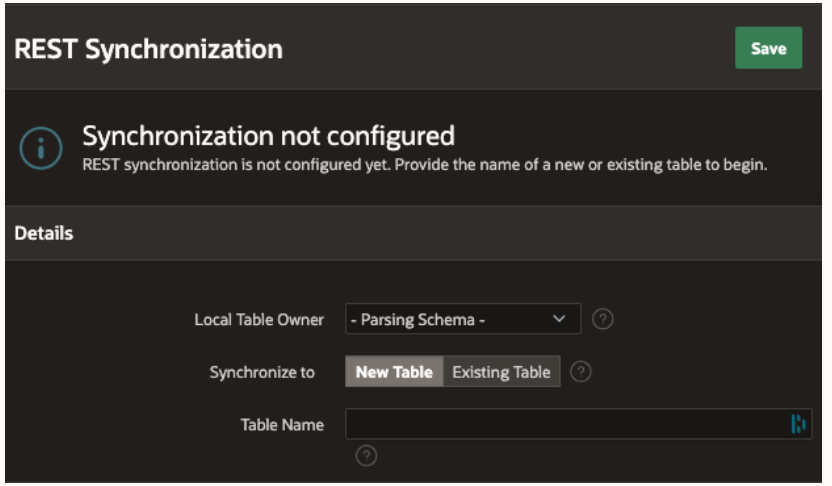
APEX Data Source | Result and Synchronization

We can now start using this data source in our application



APEX can assist in replicating the data source

- One-off creation of a local table for speed improvement
- Manual or periodical synchronization with the REST Data Source
- Synchronized table can have more columns than the source



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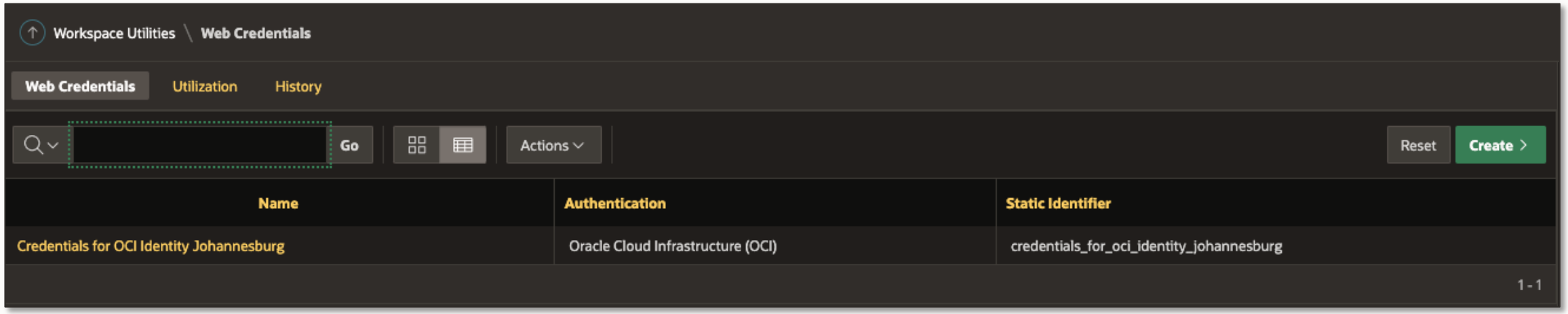
Credentials

Credentials are stored on Workspace level

- App Builder -> Workspace Utilities -> All Utilities
- Choose the Web Credentials from the list
- Can be re-used by all users with access to the Workspace



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Using the REST Data Source in APEX

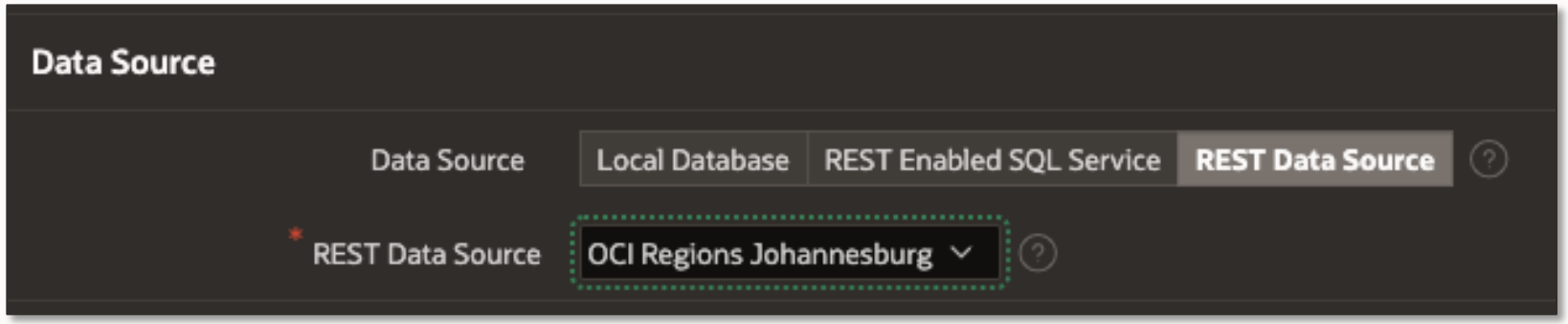
Inside our new application, create a new page

Choose applicable page type

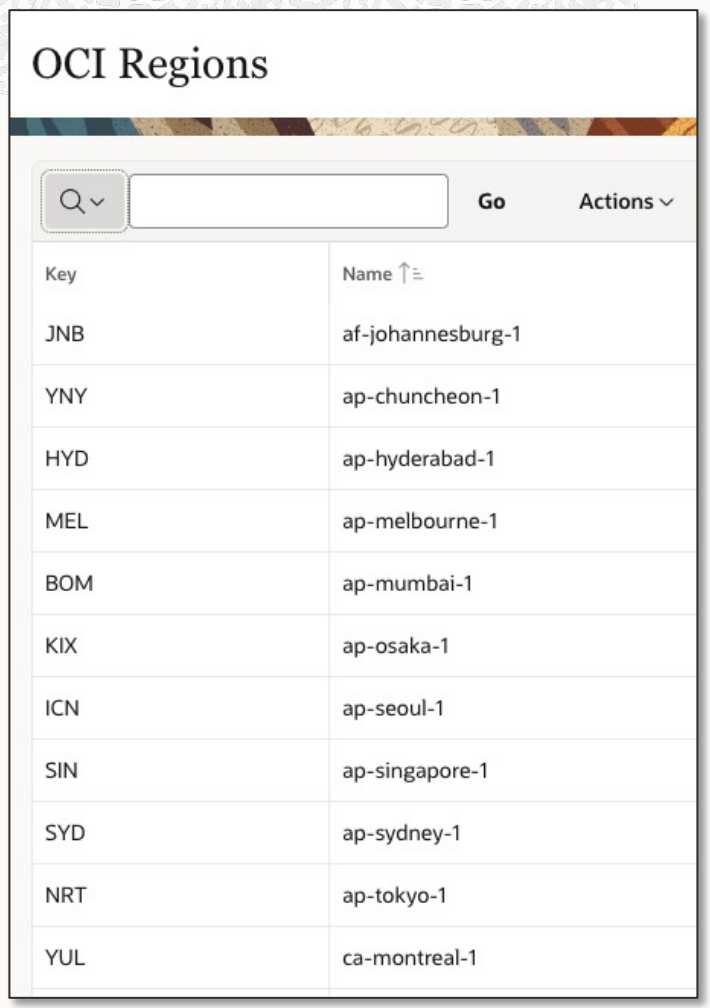
- In this example, Interactive Report

Source is the REST Data Source

- Choose our new Data Source in the drop-down list



Create the page and run the page



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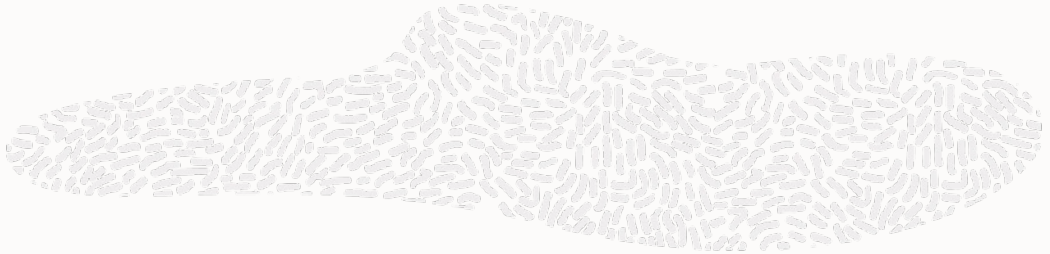
API calls from the database



Signing is needed for API calls from the database:

- Home written Java signing
- Leverage existing APEX packages
- Use DBMS_CLOUD package in Autonomous Database

Home written Java signing

- https://docs.oracle.com/en-us/iaas/Content/API/Concepts/signingrequests.htm
  - Create the signing string, which is based on parts of the request.
  - Create the signature from the signing string, using your private key and the RSA-SHA256 algorithm.
  - Add the resulting signature and other required information to the Authorization header in the request.
  - Use utl_http to send and retrieve information
- No default package for creating the signature string
  - Could be implemented by **com.oracle.bmc.http.signing.RequestSigningFilter** library
  - Need to load this package in the database before using

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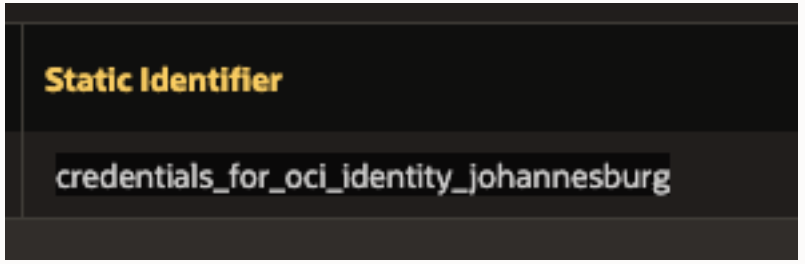
Leverage existing APEX packages

Retrieve information using APEX_WEB_SERVICE

- Function MAKE_REST_REQUEST

```
APEX_WEB_SERVICE.MAKE_REST_REQUEST (
  p_url IN VARCHAR2,
  p_http_method IN VARCHAR2,
  p_username IN VARCHAR2 DEFAULT NULL,
  p_password IN VARCHAR2 DEFAULT NULL,
  p_scheme IN VARCHAR2 DEFAULT 'Basic',
  p_proxy_override IN VARCHAR2 DEFAULT NULL,
  p_transfer_timeout IN NUMBER DEFAULT 180,
  p_body IN CLOB DEFAULT EMPTY_CLOB(),
  p_body_blob IN BLOB DEFAULT EMPTY_BLOB(),
  p_parm_name IN apex_application_global.vc_arr2 DEFAULT empty_vc_arr,
  p_parm_value IN apex_application_global.vc_arr2 DEFAULT empty_vc_arr,
  p_wallet_path IN VARCHAR2 DEFAULT NULL,
  p_wallet_pwd IN VARCHAR2 DEFAULT NULL,
  p_https_host IN VARCHAR2 DEFAULT NULL,
  p_credential_static_id IN VARCHAR2 DEFAULT NULL,
  p_token_url IN VARCHAR2 DEFAULT NULL )
RETURN CLOB;
```



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Lets give it a go

Use the same API Endpoint and method as in earlier examples:

```
select apex_web_service.make_rest_request (
     p_url                  => 'https://identity.af-johannesburg-1.oci.oraclecloud.com/20160918/regions',
     p_http_method          => 'GET',
     p_credential_static_id => 'credentials_for_oci_identity_johannesburg') as OUTPUT from dual;
```

Result:

```
OUTPUT
--------------------------------------------------------------------------------------------------------------
[{"key":"AMS","name":"eu-amsterdam-1"},{"key":"ARN","name":"eu-stockholm-1"},{"key":"AUH","name":"me-abudhabi-1"},
{"key":"BOM","name":"ap-mumbai-1"},{"key":"CDG","name":"eu-paris-1"},{"key":"CWL","name":"uk-cardiff-1"},
{"key":"DXB","name":"me-dubai-1"},{"key":"FRA","name":"eu-frankfurt-1"},{"key":"GRU","name":"sa-saopaulo-1"},
{"key":"HYD","name":"ap-hyderabad-1"},{"key":"IAD","name":"us-ashburn-1"},{"key":"ICN","name":"ap-seoul-1"},
{"key":"JED","name":"me-jeddah-1"},{"key":"JNB","name":"af-johannesburg-1"},{"key":"KIX","name":"ap-osaka-1"},
{"key":"LHR","name":"uk-london-1"},{"key":"LIN","name":"eu-milan-1"},{"key":"MAD","name":"eu-madrid-1"},
{"key":"MEL","name":"ap-melbourne-1"},{"key":"MRS","name":"eu-marseille-1"},{"key":"MTY","name":"mx-monterrey-1"},
{"key":"MTZ","name":"il-jerusalem-1"},{"key":"NRT","name":"ap-tokyo-1"},{"key":"ORD","name":"us-chicago-1"},
{"key":"PHX","name":"us-phoenix-1"},{"key":"QRO","name":"mx-queretaro-1"},{"key":"SCL","name":"sa-santiago-1"},
{"key":"SIN","name":"ap-singapore-1"},{"key":"SJC","name":"us-sanjose-1"},{"key":"SYD","name":"ap-sydney-1"},
{"key":"VCP","name":"sa-vinhedo-1"},{"key":"YNY","name":"ap-chuncheon-1"},{"key":"YUL","name":"ca-montreal-1"},
{"key":"YYZ","name":"ca-toronto-1"},{"key":"ZRH","name":"eu-zurich-1"}]

1 rows returned in 0.93 seconds
```

Making it relational using JSON_TABLE

```
select key, name
from JSON_TABLE( apex_web_service.make_rest_request (
                        p_url                   => 'https://identity.af-johannesburg-1.oci.oraclecloud.com/20160918/regions',
                        p_http_method           => 'GET',
                        p_credential_static_id  => 'credentials_for_oci_identity_johannesburg'),
                  '$[*]' COLUMNS (key, name)
                )
```

- JSON_TABLE transforms JSON into a relational table
  - Can use all regular SQL statements like WHERE etc
- We can…
  - Turn the list into a view for easier access
  - Leverage Materialized Views for faster access

KEY	NAME
AMS	eu-amsterdam-1
ARN	eu-stockholm-1
AUH	me-abudhabi-1
BOM	ap-mumbai-1
CDG	eu-paris-1
CWL	uk-cardiff-1
DXB	me-dubai-1
FRA	eu-frankfurt-1
GRU	sa-saopaulo-1

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Doing the same thing in Autonomous Database | DBMS_CLOUD

- `apex_web_service.make_rest_request` also exists in Autonomous
  - APEX is available by default in Autonomous Database
- Separate package DBMS_CLOUD available as well
  - Need to create a credential

```
DBMS_CLOUD.CREATE_CREDENTIAL ( credential_name IN VARCHAR2,
                               user_ocid       IN VARCHAR2,
                               tenancy_ocid    IN VARCHAR2,
                               private_key     IN VARCHAR2,
                               fingerprint     IN VARCHAR2);
```

  - Similar requirements as the APEX credential
  - Hint: Private key needs to be a single string without header, footer or <cr>

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Doing the same thing in Autonomous Database | Credentials

Make sure you grant the use of DBMS_CLOUD to the user (if not ADMIN)

```
grant execute on DBMS_CLOUD to WKSP_DEMOREST
```

Example:

```
begin
  DBMS_CLOUD.CREATE_CREDENTIAL ( credential_name => 'MyOciCredential',
                                 user_ocid       => 'ocid1.user.oc1..aaaaaaaa4nvl32p5hkjcGNYxc36yHQeCPbk7aqQ8HoG5h6aszT63KHRBseNY',
                                 tenancy_ocid    => 'ocid1.tenancy.oc1..aaaaaaaaafj37mytx22oquDxmd3Gzppp7dGKdGAYxop58TRx8s7DjexQQBCF5L',
                                 fingerprint     => '24:d1:77:fe:49:00:58:8f:60:4a:38:7e:43:b4:3f:55',
                                 private_key     => 'MIIEvAIBADANBgkqhkiG9w0BAQEFAASCBKYwggSiAgEAAoIBAQCLrdM3WRU2JCyB'||
                                                    'TfvuV8nIKDcdSMx91/yEBris+O7NbyZYR3zDpkkRQP5uOS/djhtkVTttphgPjkBo'||
                                                    'k2ihLeFO+DTuMRyuPkeMAwj5PaWujhM8KBRICJ4scAR+ugmQglQeeIOvFVlamcdf'||
                                                    'q02GwyudbHSl/UIQnEThWOOIDajHIFcGbTJP3IMIWXUUtgsoc8DvWJchYDm7lDbR'||
                                                    'pZ5I7WRMmnXWgavERJznUzbDxDi9nCxDPhTfRtk0rtYFjElLrBjqlf2A7VdMwR41'||
                                                    'v2isFU6asZMBTv0759JIEe3+93g2eMcbk3CpqNsb1V1tH4//kMgV2uvknIGcCSRG'||
                                                    'RlTbP2/1AgMBAAECggEABfNZ1DnPVYck/j08RmMnDYfpES5Qx+uzrkw7AeN5CPd7'||
                                                    'QreI8SzcYAfMzxVQnLe5IwUeiwVQcRk2VT4ybuttddfNKXieKC4vDh/y+etOa6lR'||
                                                    '2HY8pvT3CB2dk2iJj8Z99E5+Da9zJxD2FXVO0DbwXLyKG6g2cE64AIGw79LlJdaC'||
                                                    'wAEE+zW1c9i+l3yWaN/AbxdhVkOu9WJWeT+2OLDJKhLp6z8srK775VkkcNiISE+o'||
                                                    '23uX8kNH2hJGTIbGxaTWnsRy57wikM2aNk+Pt8pZ0rZ24khYMlVrxOPDrvbiqVTB'||
                                                    'JiVIa1y4+Xk4hOeOhVKCYmfjiFvTR3tnHtYFVu/GAQKBgQDC8w02dXSttVahZUZV'||
                                                    '0g6c4Y882qmvEodiofqvzqHZYkcsqKaxb7m+oaOhNutmQnLqcDRXmXQtYmtkDx1A'||
                                                    'Bp7KHGMQ5z6V3gIMvj1wNrD7KBqB8SMz10XkbUs1q1p251KP2K03UhgesJWgp6vf'||
                                                    'C5+fJnXPFj39y6QNAFBxoyinRQKBgQC3a8knehE3eVHS7jwwE3I5bqD/iQg3rJlP'||
                                                    '0qzuQeec/cGukvtCmGy9mZRHnUMUa8MwqkookUNwpg6Y8wjGHRxR7RkwbsnqDqOm'||
                                                    'vzr/2m22vh3jhCN9mDKbfO2LVNhFQdDmTseMLKoD2c9TUNCI5S1V9oWTnUgs9HVb'||
                                                    'SSgeLhWY8QKBgCfUnOh5iwNKv45uMLasGkw3UZqvWmfoszyVt71zTGIr0Drxok0y'||
                                                    'dJLcV6BCpknYXb5Eeo1DTxdOun5REDran2rbPkmf7G22VFjiLY9VvUczZGcUK4sV'||
                                                    '+rO3GNy4S91rWdUGAi4BWeg7T/bpCREhO1W69+r9smC+UKBPZiAxo8a5AoGAHjfO'||
                                                    'uwc8QORm25ZOKil5/wY/1fmQdgOkemceAF6xNscDmqwyYuVTvOTJbgb1ny6lyKW1'||
                                                    'c/uCndNtwjr/7gurt7+VD8qgz0O8KGOG59Hnk1y89de2NSHW7JDnXbYLr1/Ut6yw'||
                                                    '6WIOXHYM1xAQWw1Oq8Pie9BErMtVbkWeK2KyQjECgYApvJNHCSdYplfUWp7vnAh+'||
                                                    'BePBKDFeueRmeuqBfqtAtvnIeTD+bsCu8LBBh7pKagzNX5ExRBGL2HcezXui0dfW'||
                                                    'DCoh51XukswRWBlia9cERV6OedqSfGHcq6tvAorlLtIHH6gJfTzssxv2Ubssav9S'||
                                                    'X8as4I/oc21mE1opelU+ZQ==');
end;
```


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Doing the same thing in Autonomous Database | Get Regions from OCI

Using the SEND_REQUEST subprogram

```
DBMS_CLOUD.SEND_REQUEST( credential_name     IN VARCHAR2,
                         uri                 IN VARCHAR2,
                         method              IN VARCHAR2,
                         headers             IN CLOB DEFAULT NULL,
                         async_request_url   IN VARCHAR2 DEFAULT NULL,
                         wait_for_states     IN DBMS_CLOUD_TYPES.wait_for_states_t DEFAULT NULL,
                         timeout             IN NUMBER DEFAULT 0,
                         cache               IN PL/SQL BOOLEAN DEFAULT FALSE,
                         cache_scope         IN VARCHAR2 DEFAULT 'PRIVATE',
                         body                IN BLOB DEFAULT NULL);
```

Both a procedure and function

- Procedure stores output in the SESSION_CLOUD_API_RESULTS (needs cache enabled)
- Function returns a DBMS_CLOUD type
  - Use subprograms GET_RESPONSE_TEST, GET_RESPONSE_HEADERS, GET_RESPONSE_STATUS for results

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Doing the same thing in Autonomous Database | Get Regions from OCI

```
declare
  v_response    DBMS_CLOUD_TYPES.RESP;
  v_clob        clob;

begin
  v_response := dbms_cloud.send_request (
                  credential_name => 'MyOciCredential',
                  uri             => 'https://identity.af-johannesburg-1.oci.oraclecloud.com/20160918/regions',
                  method          => 'GET');

  dbms_output.put_line( dbms_cloud.get_response_text (v_response));
end;
/

[{"key":"AMS","name":"eu-amsterdam-1"},{"key":"ARN","name":"eu-stockholm-1"},{"key":"AUH","name":"me-abudhabi-1"},{"key":"BOM",
"name":"ap-mumbai-1"},{"key":"CDG","name":"eu-paris-1"},{"key":"CWL","name":"uk-cardiff-1"},{"key":"DXB","name":"me-dubai-1"},
{"key":"FRA","name":"eu-frankfurt-1"},{"key":"GRU","name":"sa-saopaulo-1"},{"key":"HYD","name":"ap-hyderabad-1"},{"key":"IAD",
"name":"us-ashburn-1"},{"key":"ICN","name":"ap-seoul-1"},{"key":"JED","name":"me-jeddah-1"},{"key":"JNB","name":"af-johannesburg-1"},
{"key":"KIX","name":"ap-osaka-1"},{"key":"LHR","name":"uk-london-1"},{"key":"LIN","name":"eu-milan-1"},{"key":"MAD","name":"eu-
madrid-1"},{"key":"MEL","name":"ap-melbourne-1"},{"key":"MRS","name":"eu-marseille-1"},{"key":"MTY","name":"mx-monterrey-1"},
{"key":"MTZ","name":"il-jerusalem-1"},{"key":"NRT","name":"ap-tokyo-1"},{"key":"ORD","name":"us-chicago-1"},{"key":"PHX","name":"us-
phoenix-1"},{"key":"QRO","name":"mx-queretaro-1"},{"key":"SCL","name":"sa-santiago-1"},{"key":"SIN","name":"ap-singapore-1"},
{"key":"SJC","name":"us-sanjose-1"},{"key":"SYD","name":"ap-sydney-1"},{"key":"VCP","name":"sa-vinhedo-1"},{"key":"YNY",
"name":"ap-chuncheon-1"},{"key":"YUL","name":"ca-montreal-1"},{"key":"YYZ","name":"ca-toronto-1"},{"key":"ZRH","name":"eu-zurich-1"}]

Statement processed.

0.96 seconds
```


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APEX_WEB_SERVICE vs DBMS_CLOUD | DBMS_CLOUD wins for me

APEX_WEB_SERVICE

- Generic REST client
- Can be used everywhere where APEX is installed
- APEX install is required
- Credential management through GUI and SQL

DBMS_CLOUD

- SEND_REQUEST only available in Autonomous Database
- Faster than APEX_WEB_SERVICE
- Better suited for OCI requests
  - Asynchronous calls, Workrequests, timeouts waiting for async to finish, the client already in OCI Cloud
- PL/SQL only
  - Cannot nest two calls in one SQL statement, needs variables

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Things to be aware of | Headers and multiple pages

HTTPS requests and answers contain headers

- Most headers are handled by the packages automatically
- Important header when specified is '**opc-next-page**' header

OPC-NEXT-PAGE indicates not all results have been transmitted

- Results limited by size of result or setting of the '**limit=<# of records>**' query parameter
- To retrieve all results, one or more additional calls need to be made (loop)
- Use the same URI appended by parameter '**page=<value from opc-next-page>**'

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Things to be aware of | Pagination

```
declare
  v_tenancy_ocid      varchar2(200) := 'ocid1.tenancy.oc1..aaaaaaaafj37mytx22oquorcznlfuh77cd45int7tt7fo27tuejsfqbybzrq';
  v_response          DBMS_CLOUD_TYPES.RESP;
  v_response_text     clob;
  v_response_headers  clob;
  v_opc_next_page     varchar2(2000) := 'Initial run';
  v_uri_next_page     varchar2(2000);

begin

  while v_opc_next_page is not null loop

    v_response := dbms_cloud.send_request (
                  credential_name      => 'MyOciCredential',
                  uri                  => 'https://identity.af-johannesburg-1.oci.oraclecloud.com/20160918/users/?compartmentId='||
                                                                                    v_tenancy_ocid||'&limit=25'||v_uri_next_page,
                  method               => 'GET');


    v_response_text    := replace(v_response_text || dbms_cloud.get_response_text (v_response), '][', ',');
    v_response_headers := dbms_cloud.get_response_headers (v_response).to_clob;

    v_opc_next_page := JSON_VALUE (v_response_headers, '$."opc-next-page"');
    v_uri_next_page := '&page='||v_opc_next_page;


  end loop;

end;
```


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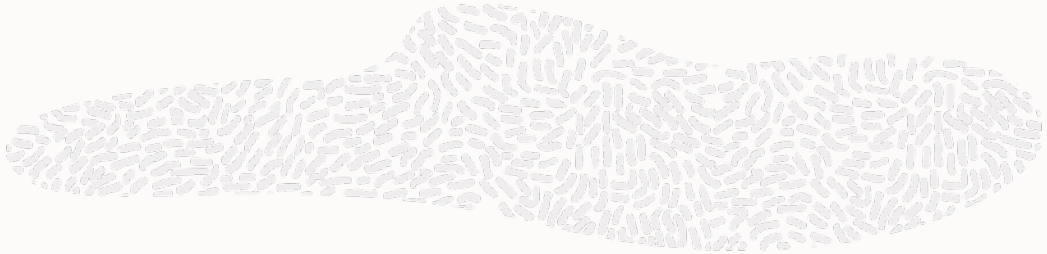
Things to be aware of | Sending Headers



- HTTPS requests and answers contain headers
  - Most headers are handled by the packages automatically
  - Sometimes additional headers for sending are needed
  - Example: Proxy authentication

```
apex_web_service.g_request_headers( 1 ).name := 'Proxy-Authentication';
apex_web_service.g_request_headers( 1 ).value := base64({username}:{pw});
```

- ALWAYS clear your headers after setting them
  - Not clearing them can cause unexpected results
  - Debugging old headers is very difficult

```
apex_web_service.g_request_headers.delete();
```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Things to be aware of | Wallet with root certificates

- All OCI REST endpoints are HTTPS
  - DigiCert root certificates are needed for this

- By default in Autonomous Database
  - Will be needed in other environments
    - Download the SSL root and intermediate certificates.
      - Root certificate: DigiCert Global Root G2
      - Intermediate certificate: DigiCert Global G2 TLS RSA SHA256 2020 CA1
    - Create the auto login wallet with the following command:
      - orapki wallet create -wallet /home/oracle/MyWallet -pwd "PAssword_#123" -auto_login
      - orapki wallet create -wallet /home/oracle/MyWallet -pwd "PAssword_#123" -auto_login
    - Add the certificates to the wallet with the following commands:
      - orapki wallet add -wallet /home/oracle/MyWallet -trusted_cert -cert "/home/oracle/DigiCertGlobalRootCA.crt" -pwd PAssword_#123
      - orapki wallet add -wallet /home/oracle/MyWallet -trusted_cert -cert "/home/oracle/DigiCertSHA2SecureServerCA.crt" -pwd PAssword_#123

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Things to be aware of | Wallet with root certificates

- Generic script for root certificates
  - **https://github.com/Dani3lSun/oracle-ca-wallet-creator**
  - After running, creates an Oracle wallet and a password
  - Add wallet as default to the APEX installation through the GUI or SQL

```
begin
  apex_instance_admin.set_parameter('WALLET_PATH' ,'file:/path/to/wallet');
  commit;
end;
```

  - Above example is for auto-login wallets. When password is needed:

```
begin
  apex_instance_admin.set_parameter('WALLET_PWD' ,'<pwd-from-pwd-file>');
  commit;
end;
```


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Things to be aware of | Network Access Control Lists (ACL)

- Oracle 11g introduced Fine Grained Network Access Control
  - Requires Access Control Lists to be able to contact the outside world

- Not required for DBMS_CLOUD and APEX_WEB_REQUEST on Autonomous Database
  - All HTTPS endpoints are enabled
  - Need it for UTL_HTTP

- Non-Autonomous databases need to setup ACL inside the database
  - Using DBMS_NETWORK_ACL_ADMIN package

```
DBMS_NETWORK_ACL_ADMIN.APPEND_HOST_ACE(
  host => '*.oraclecloud.com',
  ace => xs$ace_type( privilege_list => xs$name_list('connect', 'resolve'),
                      principal_name => 'scott',
                      principal_type => xs_acl.ptype_db));
```


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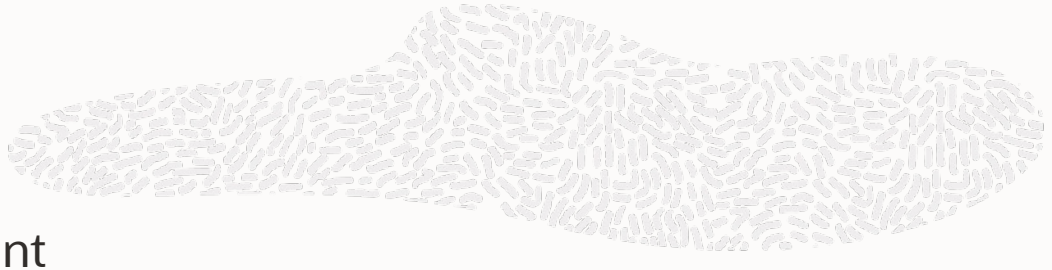
Things to be aware of | Proxy settings



- Database instance needs to be able to reach the endpoint
  - Routing through NAT gateway does not require additional setup
  - Make sure the Egress rules of your firewall allow access to the endpoints

- If no direct routing or NAT gateway exists, proxy can be used
  - Make sure the ACL to the proxy server is allowed in the database
  - Set the proxy as default value in the APEX application
    - Workspace INTERNAL, Manage Instance, Security
  - or
  - Add proxy hostname in the call to APEX_WEB_SERVICE

```
p_proxy_override IN VARCHAR2 DEFAULT NULL,
```

APEX does not explicitly support passwords but request headers might be leveraged

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Things to be aware of | Asynchronous Operations

- Not all REST API action requests will be executed immediately
  - Some calls will return SUCCESS because a Work Request has been successfully submitted
  - Example direct execution
    - create a new user
  - Example Workrequest
    - Create a new Base Database

- Not all changes will be visible everywhere after the request was reported successful
  - Examples:
    - Permissions, Quotas, Compartment creation, Virtual Networks and more
    - No list exists that states the delay or ways to test if you can use the new/changed resource
  - Some changes need to be synchronized over regions
    - Could take 30 seconds to 5 minutes before changes are usable by the process or user

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Complex Operation | One thing leads to another

- Resources sometimes depend on other resources before they can be created
- Example:
  - A request for a new database requires a "request body" that a needs a dbHomeId
    - This is the OCID of the Database Home where the new database will reside
  - dbHomeId needs a separate call which needs a dbSystemId
    - The OCID of the DB System (= VM where the database is running)
  - dbSystemId needs a separate call which needs a SubnetId
    - On which network subnet is the database attached
  - SubnetId needs a separate call which requires a vcnId

  - Before you can connect to the database, you need to add gateways, firewall rules to the VCN and subnet

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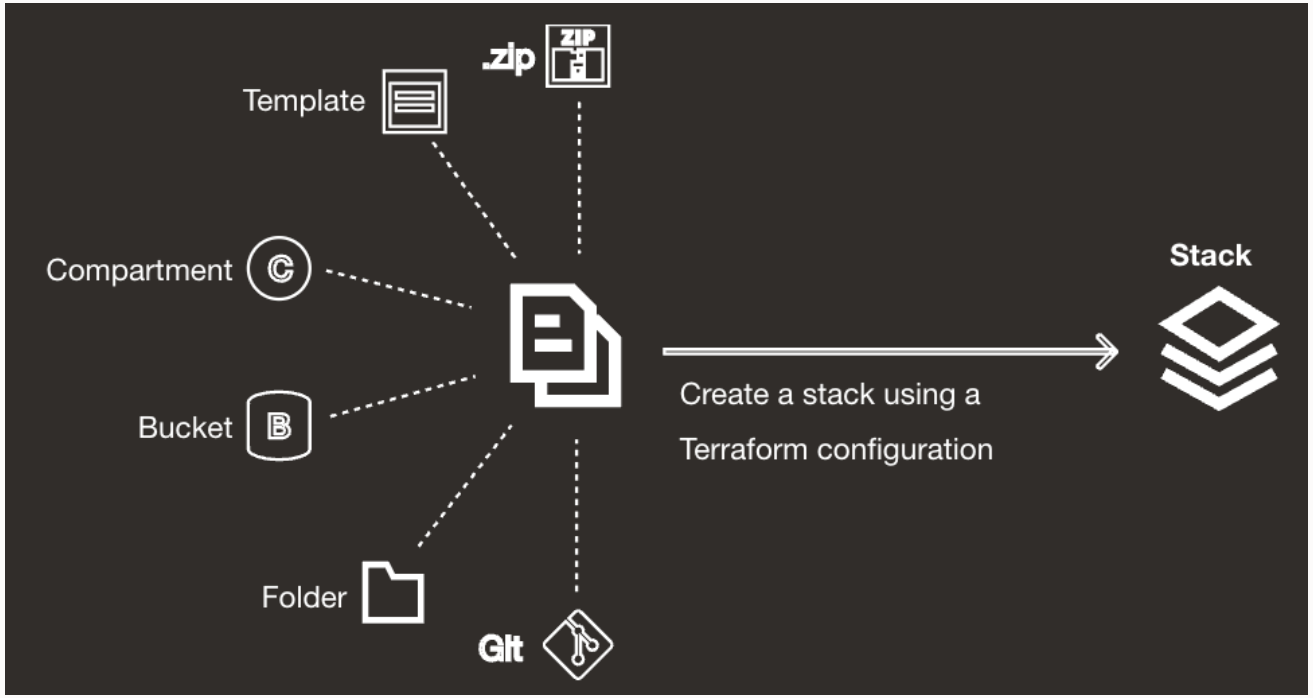
Alternative options to REST calls | Resource Manager (= Terraform)

- OCI Resource Manager can apply Stacks for resource creation
  - A Stack is a Terraform configuration
  - Use it to provision and manage OCI resources

- Stacks can be created using REST API
  - Private Template
  - Zipfile
  - Source Control System
    - Github, Gitlab, Bitbucket, DevOps etc

- Generic Terraform options are available
  - Multiple files
  - Parameters and Variables



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Alternative options to REST calls | PL/SQL SDK

- The Oracle Cloud Infrastructure SDK for PL/SQL enables you to write PL/SQL code to manage Oracle Cloud Infrastructure resources.
  - Only available on Autonomous Database Serverless (Autonomous Databases using shared Exadata infrastructure)

- Translation of REST API calls into PL/SQL functions and packages
  - Not all API options available
    - For example, our REGIONS call
  - Same input needed as REST API calls

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Alternative options to REST calls | PL/SQL SDK example

Example

```
declare
  response_body   dbms_cloud_oci_object_storage_bucket_t;
  response        dbms_cloud_oci_obs_object_storage_create_bucket_response_t;
  bucket_details  dbms_cloud_oci_object_storage_create_bucket_details_t;
begin
  bucket_details := dbms_cloud_oci_object_storage_create_bucket_details_t();
  bucket_details.name := 'bucketname';
  bucket_details.compartment_id := 'compartment_OCID';

  response := dbms_cloud_oci_obs_object_storage.create_bucket(
                        namespace_name         => 'namespace-string',
                        opc_client_request_id  => 'random-request-id',
                        create_bucket_details  => bucket_details,
                        credential_name        => 'OCI_KEY_CRED',
                        region                 => 'region-identifier');

  response_body := response.response_body;

  dbms_output.put_line(response_body.id);
  dbms_output.put_line(response_body.name);
end;
/
```


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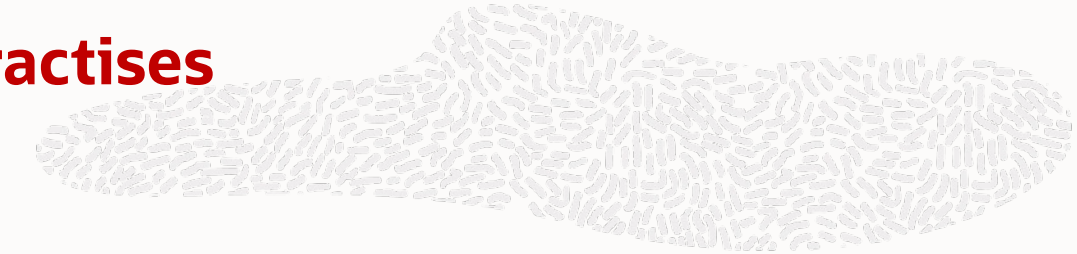
Hard-code or store in tables | My best practises



- Store all static or refreshable information in tables
  - oci_regions
  - oci_endpoints

- Write functions or procedures for each API call
  - There is an SDK for PL/SQL already, can leverage this
  - Write your own code using REST API for the specific function or
  - Submit Stacks (= Terraform) for more complex setups

Standardize your calls for GET, PUT etc

  - Especially handling the pagination issues during data retrieval

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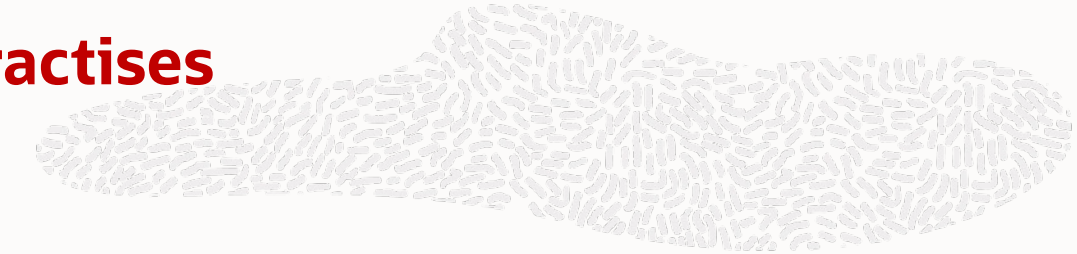
Hard-code or store in tables | My best practises



Use lots of parameters

- Impossible to compile something that is running in the background
- At least create something that will kill/stop all jobs

Write your own job system where individual steps are executed and results are logged

- CREATE_DATABASE can automatically trigger CREATE_DBHOME and CREATE_DBSYSTEM
- CREATE_DBSYSTEM can automatically trigger for CREATE_SUBNET
- CREATE_SUBNET can automatically trigger CREATE_VCN
- Mandatory waits can be programmed into the steps

Run 1 DBMS_JOB per request

- Make sure the database is not created before the VCN is available
- Best result is doing things serially but a lot of requests at the same time

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Example Livelabs

STEPS

STEP_ID	DESCRIPTION
001	Create Database
002	Create VCN
003	Create User
004	Create Instance
005	Create Compartment
006	Set policies for user
007	Execute Terraform script

WORKSHOP

WS_ID	NAME
001	How to create a VCN
002	23c new features
003	Social Media App
004	Intro to ADB

WS_STEPS

WS_ID	STEP_ID
001	003
001	005
001	006
002	003
002	002
002	004
003	003

RESERVATION

RES_ID	WS_ID	EMAIL
001	001	robert.pastijn@oracle.com
002	001	john.abrahams@oracle.com
003	002	robert.pastijn@oracle.com
004	003	some.user@somedomain.com

RES_STEPS

RES_ID	STEP_ID	STATUS	RESULT
001	003	complete	ocid1.user.oc1.xxx
001	005	complete	ocid1.compartment.oc1.xxx
001	006	complete	ocid1.policy.oc1.xxx
002	003	complete	ocid1.user.oc1.xxx
002	002	running	
002	004	new	
003	003	failed	ORA-1234: tenancy out of users

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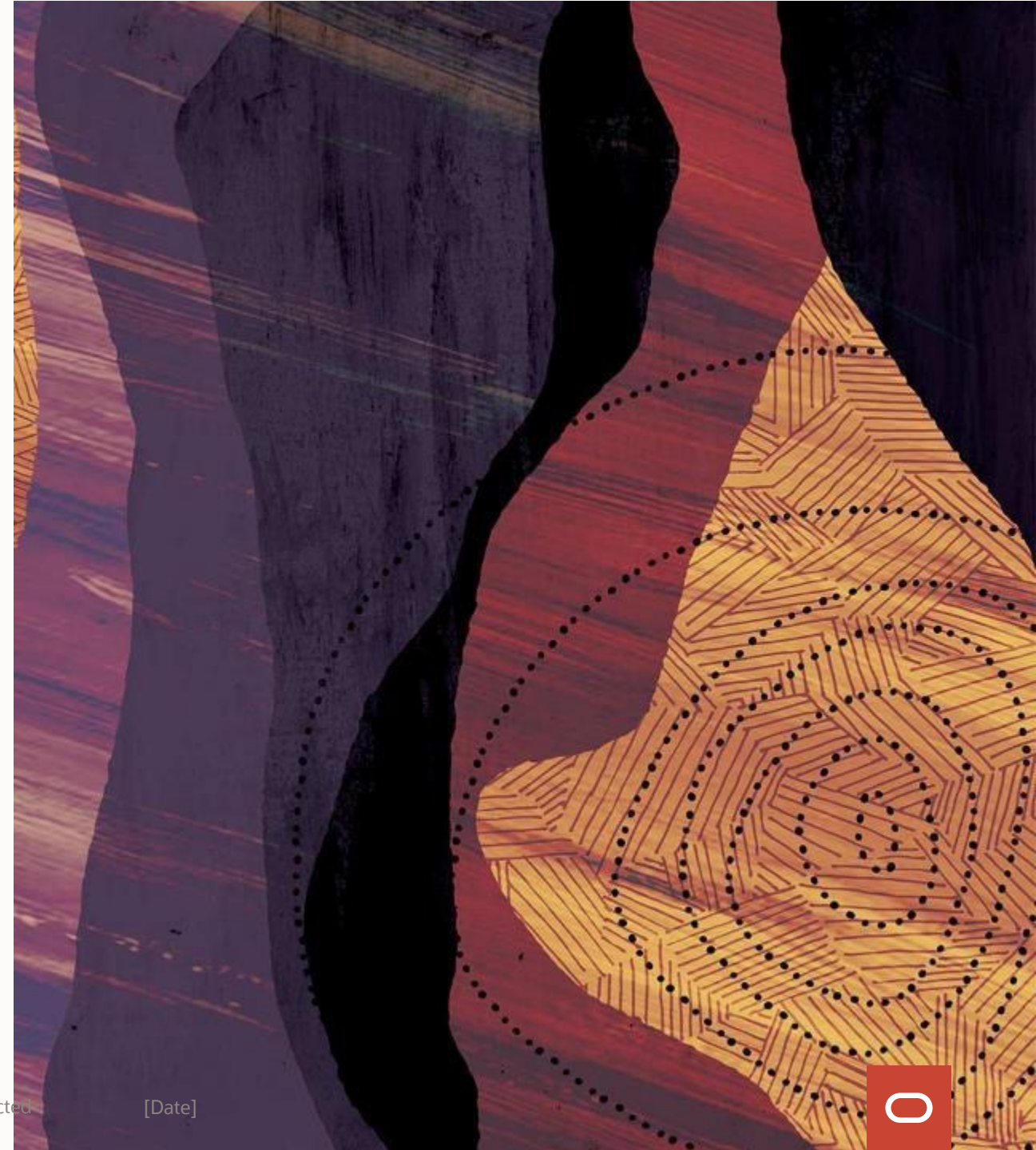
Thank you



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