

CTA LAB 2018

Collaborative 5G Edge API

hands-on session

Dallas, TX 2018

Table of Contents

1. INTRODUCTION	3
2. ARCHITECTURE	3
3. ENVIRONMENT SETUP.....	4
3.1. CREATE AN IBM CLOUD ACCOUNT (SKIP IF YOU HAVE ONE).....	4
3.2. CREATE A KUBERNETES INSTANCE ON IBM CLOUD.....	5
3.3. INSTALL IBM BLUEMIX CLI	6
3.4. INSTALL NODE.JS	7
3.5. INSTALL API CONNECT CLI	7
3.6. INSTALL KUBERNETES CLI.....	7
3.7. CREATE A WATSON ASSISTANCE SERVICE.....	7
3.8. CREATE APIC INSTANCE.....	9
4. SECTION1 - DEPLOY THE TMF OPEN DIGITAL ON IBM CLOUD ON KUBERNETES.....	11
5. SECTION 2 – CREATING A SELF-CARE APP.....	13
5.1. MICROSERVICES.....	13
5.1.1. <i>API Connect</i>	13
5.1.2. <i>Create an APIC project using CLI</i>	14
5.1.3. <i>Accessing database credentials</i>	14
5.1.4. <i>Create a data Source</i>	15
5.1.5. <i>Create API's using a swagger file</i>	16
5.1.6. <i>Edit Model and API</i>	17
5.1.7. <i>Sample input data to be inserted into database</i>	19
5.1.8. <i>Test and Explore your Loopback application</i>	19
5.1.9. <i>Publish in IBM Cloud</i>	21
5.1.10. <i>Test API getting data</i>	24
5.2. FUNCTIONS AS A SERVICE (SERVERLESS APPLICATIONS).....	24
5.2.1. <i>IBM Functions</i>	24
5.2.2. <i>Access IBM Functions</i>	25
5.2.3. <i>Get IBM Functions credentials</i>	25
5.2.4. <i>Create action 1 and test</i>	26
5.2.5. <i>Create action 2 and test</i>	28
5.2.6. <i>Create action 3 and test</i>	30
5.3. AI POWERED CHATBOT	31
5.3.1. <i>Watson Assistant</i>	31
5.3.2. <i>Creating a workspace by uploading a JSON</i>	31
5.3.3. <i>Edit the dialog Nodes to point to the correct IBM Functions</i>	32
5.3.4. <i>Test the robot</i>	33
5.4. INTERFACING WITH THE END USER	34
5.4.1. <i>Node-red UI</i>	34
5.4.2. <i>Navigate to Node-Red flow editor</i>	34
5.4.3. <i>Change credentials (optional)</i>	36
5.4.4. <i>Access the UI and test the use case</i>	38

1. Introduction

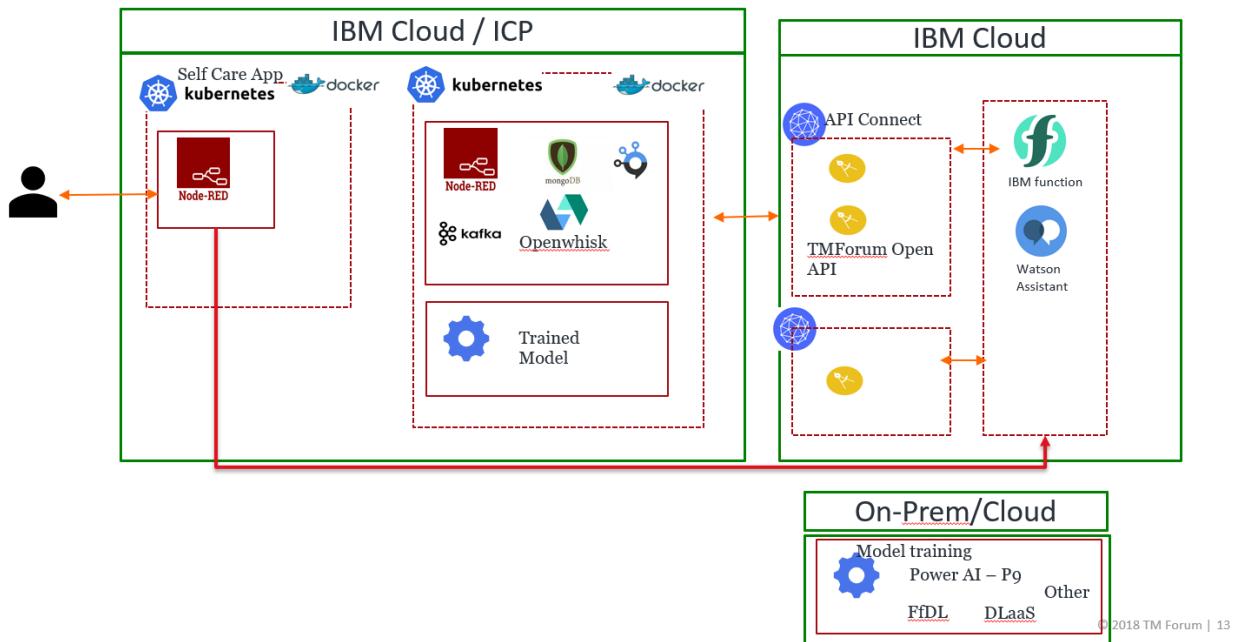
The Open Digital Lab provides a safe space for inter-company collaborative proof of concept generation leveraging open standards. With the pace of change in the industry continuing to accelerate, and partnerships with other companies to deliver new services and solutions increasing in importance, there has never been a greater need for an environment for collaborative co-creation of innovative new solutions and services. The TM Forum Open Digital lab hosted by IBM provides this environment where inter-company proof of concepts can be rapidly developed, tested and iterated.

The Open Digital Lab is a member benefit for the 900-member companies who are joined TM Forum. To access the lab, first sign up for a free IBM Cloud account and connect to the TM Forum space where a feast of tools available for rapid innovation. These include but are not limited to:

- Live reference implementations of TM Forum's Open APIs
- Easier access to rapid testing of in development or deployed TMF Open APIs
- Access a series of open source technologies
- In a safe place for co-creation and iteration

The first wave of innovative projects to use the Open Digital lab are the proof of concept catalyst projects being developed for Digital Transformation World 2018 & 2019.

2. Architecture



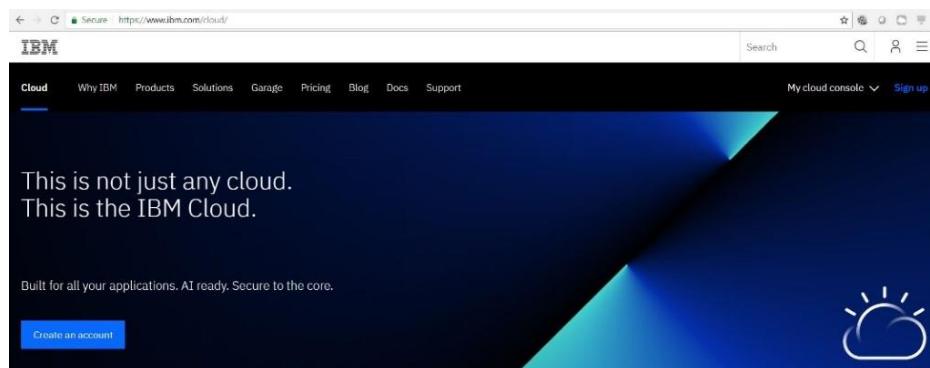
Github repository link for the lab: https://github.com/commgsc/CTA_LAB_2018

3. Environment Setup

3.1. Create an IBM Cloud Account (Skip if you have one)

- Step (1)

Navigate to www.ibm.com/cloud, Click the Blue “Create Account” Button

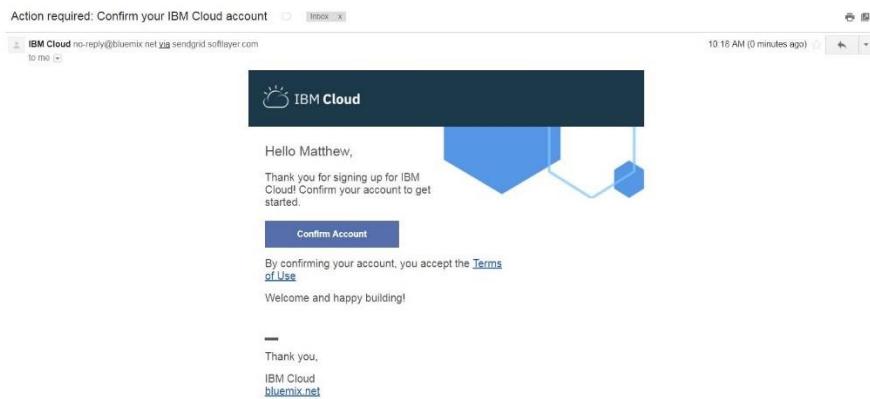


- Step (2)

Create your account details and password

A screenshot of the IBM Cloud sign-up form. The left side has promotional text: "Sign up for an IBMid and create your IBM Cloud account", "Build on IBM Cloud for free with no time restrictions", "Guaranteed free development with Lite plans", "Start on your projects right away", and "Get a \$200 credit when you upgrade". The right side is the sign-up form with fields for Email*, First Name*, Last Name*, Country or Region*, and Password*. There are also checkboxes for marketing consent and a link to withdraw consent. A "Ready to get started? Sign up today!" button is at the bottom.

You will receive an Account Confirmation Email at the address you provided. Click the blue “Confirm Account” button within the email.



You will immediately be provided with a copy of the IBMid Privacy Policy. Read the policy, then click “Proceed”

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+ What data does IBM collect?

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+ How IBM uses your data

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+ How long we keep your data

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Acknowledgement

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Write down your organization information:

Table 1:

Organization:	
Space:	

3.2. Create a Kubernetes Instance on IBM Cloud

To create a free cluster:

1. Login to IBM Cloud using <https://bluemix.net/>, from the [IBM Cloud Catalog](#) select **Containers** category and click **Containers in Kubernetes Clusters**.
2. Read up on clusters, then click **Create**. Select Location as **US South** and enter a **Cluster Name**. The default cluster type is free. Next time, you can create a standard

cluster and define additional customizations, like the number of worker nodes. The cluster will be deleted after 30 days on the lite account.

3. Click **Create Cluster**. The details for the cluster open, but the worker node in the cluster takes about 30 minutes to provision. You can see the status of the worker node in the **Worker nodes** tab. When the status reaches Ready, your worker node is ready to be used.

References:

https://console.bluemix.net/docs/containers/container_index.html#container_index

3.3. Install IBM Bluemix CLI

IBM Cloud CLI provides the command line interface to manage applications, containers, infrastructures, services and other resources in IBM Cloud. Installing IBM Cloud CLI using below commands should install kubectl, docker, git and IBM Cloud plug-ins.

- For Mac and Linux, open a terminal and run the following command:

```
curl -sL https://ibm.biz/idt-installer | bash
```

- For Windows 10, run the following command as an administrator (Right-click the Windows PowerShell and select **Run as administrator**)

```
Set-ExecutionPolicy Unrestricted; iex(New-Object  
Net.WebClient).DownloadString('http://ibm.biz/idt-win-installer')
```

Did not work? Try copying the command using the button from the following link as shown below:

<https://console-dal10.bluemix.net/docs/cli/index.html#overview>

Step 1. Run the install command

- For Mac and Linux, run the following command:

```
curl -sL https://ibm.biz/idt-installer | bash
```

- For Windows 10 Pro, run the following command as an administrator:

```
Set-ExecutionPolicy Unrestricted; iex(New-Object Net.WebClient).DownloadString('http://ibm.biz/idt-win-installer')
```

 **Tip:** Right-click the Windows PowerShell icon, and select **Run as administrator**.

3.4. Install Node.js

Install nodejs from <https://nodejs.org/en/download/> which also installs npm.
(Please install version 8.12.0 (recommended))

You can verify the versions of the required or pre-installed software by running the following commands and ensuring that you have the following versions (or higher).

3.5. Install API Connect CLI

Install IBM API Connect v5 developer toolkit: IBM API Connect is an end-to-end API management solution that uses Loopback to create APIs and provides integrated build and deployment tools. Install IBM API Connect v5 developer toolkit using “**npm install -g apiconnect**” on windows and “**sudo npm install -g apiconnect**” on Mac or Linux.

You can verify the versions of the required or pre-installed software by running the following commands and ensuring that you have the following versions (or higher).

```
C:\Users\SaiGorti>apic --version  
API Connect: v5.0.8.4-iFix (apiconnect: v2.8.39)
```

3.6. Install Kubernetes CLI

kubectl is the Kubernetes command-line tool to deploy and manage applications on Kubernetes. Using kubectl, you can inspect cluster resources; create, delete, and update components; and look at your new cluster and bring up example apps. Install kubectl using the link <https://kubernetes.io/docs/tasks/tools/install-kubectl/> (only if installing IBM Cloud CLI in section 3.3 has not installed kubectl).

To verify installation of kubectl, open command line or terminal and run “**kubectl --help**”. If it returns list of commands, then kubectl is installed already. If not got to the above link and install kubectl.

3.7. Create a Watson Assistance service

- Create Watson Assistant service

Navigate to ‘Catalog’ section in IBM Cloud.

Select ‘Watson Assistant’ in ‘AI’ Category (as shown in image below).

The screenshot shows the IBM Cloud Catalog interface. On the left, there's a sidebar with 'All Categories' and a list of services under 'AI'. The 'Watson Assistant (formerly Conversation)' service is highlighted with a red box. To its right are other AI services: 'Discovery', 'Language Translator', and 'Natural Language Understanding'. Each service has a small icon, a name, and a brief description.

Click ‘Create’

This screenshot shows the detailed view of the 'Watson Assistant (formerly Conversation)' service. It includes fields for 'Service name', 'Region/location to deploy in', 'Organization', and 'Space'. Below these are sections for 'Images' (with three preview screenshots) and 'Help' (with links to 'View Docs', 'Contact Sales', and 'Cost Calculator'). At the bottom right is a prominent blue 'Create' button, which is also highlighted with a red box.

- Create a workspace:

Once Watson assistant service is created, you will be able to see this screen.

This screenshot shows the Watson Assistant service dashboard. It features a 'Launch tool' button (highlighted with a red box), 'Getting started tutorial', and 'API reference'. Below this is a 'Credentials' section with fields for 'Url', 'Username', and 'Password', each with a copy icon. At the top right, there are 'Plan: Lite' and 'Upgrade' options.

Click “Launch tool” and you will be able to access the workspaces. Click “View details” of your workspace to see the “Workspace_ID”

- **Get the Service Credentials:**

Please make a note of username and password of the Watson assistant service and workspace id of the workspace created. Copy the username and password and make it readily accessible for further operations.

Table 2:

Username:	
Password:	
Workspace ID:	

3.8. Create APIC instance

- **Step (1)**

Within the IBM Cloud Dashboard, navigate to the Catalog using the “Catalog” Button in the upper toolbar

- **Step (2)**

Once in the Catalog, Search for “**API Connect**” and click the Description Card. Alternatively, click the “**Integration**” Category in the Left-hand filter menu and look for “**API Connect**” as shown.

The screenshot shows the IBM Cloud Catalog interface. On the left, there's a sidebar with 'All Categories' and a 'Integration' section that is currently selected, indicated by a blue background and a right-pointing arrow. The main area is titled 'Integration' and contains several service cards:

- API Connect** (Lite • IBM): Create, manage, enforce, and run APIs. This card is highlighted with a red box.
- App Connect** (Lite • IBM): Connect your applications, automate tasks, and improve productivity.
- Event Streams** (IBM): IBM Event Streams is a high-throughput message bus built with Apache Kafka. It is optimized for event ingestion into IBM Cloud and event stream distribution between your...
- Lift CLI** (IBM): Migrate your data quickly, easily and securely from your on-premises data source to an IBM Cloud data property.
- MQ** (IBM): Enterprise-grade messaging hosted in the cloud.
- Secure Gateway** (IBM): IBM Secure Gateway for Bluemix enables users to integrate cloud services with enterprise systems on premises.
- Rocket Mainframe Data** (Third Party): Rocket Mainframe Data Service on IBM Cloud provides an easy way to leverage your mainframe data for new cloud services and mobile apps. Built on our proven data...
- SPLICE Pre-CAT Insurance Notifications** (Third Party): Pre-CAT Notifications for Insurance Companies.

- **Step (3)**

Give your API Connect service name and select the region, organization and space from the dropdown lists to create API Connect service.

The screenshot shows the 'Create API Connect' dialog box. It has the following fields:

- Service name:** A text input field containing 'API Connect-selfcare' with a red box around it.
- Choose a region/location to deploy in:** A dropdown menu set to 'US South'.
- Choose an organization:** A dropdown menu set to 'saisrinivas.gorti@ibm.com'.
- Choose a space:** A dropdown menu set to 'srinu'.

Features

- **Securely unlock existing IT assets**: Rapidly generate Swagger compliant APIs from backend data sources. Iteratively design and test APIs thereby shortening development cycles.
- **Community & Subscription management**: Create developer communities to publish and share APIs and engage with them through a self-service portal. Also manage the subscriptions of the API to ensure easy consumption.
- **Graphical API assembly**: Graphically assemble the API invocation flow and apply policies that need to be enforced for secure controlled access.
- **Gain insights about API consumption**: Built-in analytics and customized dashboards empower businesses to make informed decisions.

At the bottom right, there is a large blue 'Create' button with a red box around it.

- **Step (4)**

You will then be redirected to the IBM Cloud Dashboard. Your API Connect Service will appear under the “Cloud Foundry Services” Header.

4. Section1 - Deploy the TMF Open Digital on IBM Cloud on Kubernetes

After about 30 mins, your cluster on the Kubernetes service should be ready. Navigate to the IBM Cloud dashboard <https://console.bluemix.net/>

Find your cluster as shown below:

Name	Location	Kube version	Status
mycluster	US South	1.10.8_1524	Normal

Gain access to your cluster:

Open a terminal and log into ibmcloud using the following command:

ibmcloud login -a <https://api.ng.bluemix.net> (or) ibmcloud login --sso

Once you have logged in, you need to set the environment variable and download the Kubernetes configuration files. Run the below command with your cluster name.

ibmcloud cs cluster-config *YOUR CLUSTER NAME*

Set the KUBECONFIG environment variable. Copy the output from the previous command and paste it in your terminal. The command output should look like the following.

```
export KUBECONFIG=/Users/$USER/.bluemix/plugins/container-service/clusters/mycluster/kube-config-hou02-mycluster.yml
```

Verify that you can connect to your cluster by listing your worker nodes

kubectl get nodes

The above instructions are also available for your cluster in the access tab as shown below:

Gain access to your cluster

Prerequisites
Download and install a few CLI tools and the IBM Kubernetes Service plug-in.

```
curl -sL https://ibm.biz/1dt-installer | bash
```

Gain access to your cluster

1. Log in to your IBM Cloud account.
`ibmcloud login -a https://api.ng.bluemix.net`
2. Target the IBM Cloud Container Service region in which you want to work.
`ibmcloud cs region-set us-south`
3. Get the command to set the environment variable and download the Kubernetes configuration files.
`ibmcloud cs cluster-config mycluster`
4. Set the KUBECONFIG environment variable. Copy the output from the previous command and paste it in your terminal. The command output should look similar to the following.
`export KUBECONFIG=/Users/$USER/.bluemix/plugins/container-service/clusters/mycluster/kube-config-hou02-mycluster.yaml`
Alternatively, you may directly [download](#) your kubeconfig files to manually configure the Kubernetes cluster context.
5. Verify that you can connect to your cluster by listing your worker nodes.
`kubectl get nodes`

Deploy the Lab on cluster:

Go to the git hub repo and download the sandbox.yaml file. The link is provided below:

https://github.com/commgsc/CTA_LAB_2018/blob/master/Kubernetes/sandbox.yaml

`kubectl create -f https://raw.githubusercontent.com/commgsc/CTA_LAB_2018/master/Kubernetes/sandbox.yaml`

The above command deploys the TM Forum Open Digital Lab which comprises of containerized microservices for mongodb, mqtt, kafka, openwhisk and environments for development on nodejs and node-red. In addition, it also contains a deep learning models for visual recognition.

Navigate to IBM Cloud dashboard using this link <https://console.bluemix.net/>. Click on your cluster in the clusters section. Click “**Worker Nodes**” tab to note your public IP.

Launch “**Kubernetes Dashboard (Beta)**”. Click services in the menu on left and get the port number for nodered-app as shown below.

Name	Port	Protocol
nodered-app	32323	TCP

Use the Public IP and port number in the format below to access the node red application.

Node-red Flow editor:

Url - Public IP: port (Ex: 184.172.214.2:32323)

This url opens the node-red application with a pre-defined flow.

5. Section 2 – Creating a self-care app

5.1. Microservices

5.1.1. API Connect

IBM API Connect integrates IBM API Management and IBM **Strong Loop** into a single package with built-in gateway, which allows you to create, secure, run and manage APIs and Microservices. IBM API Connect utilizes Strong Loop capabilities to rapidly build API's and Microservices using Node.js – Loopback and Express frameworks. It uses Model driven approach to create API's, map models to back-end systems using available connectors.

For this lab, we took the swagger files from TMF OPEN API TABLE and using the definitions and paths defined in the swagger files, we were able to generate persistent models using API Connect (apic command line). These models generated

stores and retrieves information from MongoDB. Once the models are generated and linked to database, we tested the models and were able to push it to **IBM API Connect** on **IBM Cloud**. Thus, creating APIs which can be accessed anywhere. The deployment of TMF APIs is explained in the API Connect Hands-on section of appendix.

5.1.2. Create an APIC project using CLI

Open command line or Terminal and run the loopback application generator “**apic loopback**” to create a new application and follow the prompts to give your application a name and hit “**enter**” to have a default directory of project, select “**3.x (current)**” as the loopback version and select “**empty-server**” option to create an empty LoopBack API.

```
C:\Srinivas\IBM projects\apic-test>apic loopback
? What's the name of your application? AccountAPI
? Enter name of the directory to contain the project: AccountAPI
? Which version of LoopBack would you like to use? 3.x (current)
? What kind of application do you have in mind?
> empty-server (An empty LoopBack API, without any configured models or datasources)
  hello-world (A project containing a controller, including a single vanilla Message and a single remote method)
  notes (A project containing a basic working example, including a memory database)
```

Running **apic** command for the very first time asks for a couple of prompts for review of license terms. Just hit “**yes**” and the next prompt would be for feedback, just hit “**no**”.

5.1.3. Accessing database credentials

Navigate to IBM Cloud dashboard using this link <https://console.bluemix.net/>. Click on your cluster in the clusters section. MongoDB is installed into kubernetes cluster as a part of section 4.1.1. Below steps will explain how to get its credentials.

Click “**Worker Nodes**” tab to note your public IP.

The screenshot shows the Kubernetes Dashboard (Beta) interface. At the top, there are tabs for Clusters, CatalystACluster, Overview, Worker Nodes (which is selected and highlighted with a red box), and Worker Pools. Below the tabs is a search bar and a "Add workers" button. The main area displays a table titled "Worker Nodes" with columns: Name, Status, Worker Pool, Zone, Private IP, Public IP (redacted), and Kubernetes Version. One row is visible: w1, Normal, default, da10, [redacted], 1.9.7_1512. At the bottom of the table, there are pagination controls showing 1 of 1 pages.

Launch “**Kubernetes Dashboard (Beta)**” to get the port number of mongodb service. Navigate to “**Discovery and load balancing --> Services**”.

Look for mongodb service endpoints, default port number for mongodb is 27017, note down the other port number.

Host	Ports (Name, Port, Protocol)	Node	Ready
172.30.144.34	sandbox-mongodb-port, 27017, TCP	10.176.210.230	true
172.30.144.35	sandbox-mongodb-port, 27017, TCP	10.176.210.230	true

These credentials are used to access the mongoDB published on kubernetes cluster.
Note down the host and port of mongodb.

Table 3:

Host:	
Port:	

5.1.4. Create a data Source

This can be done using CLI as well as API designer. Use the above noted Public IP address as host and port to connect the database. Navigate to the application folder you just created using “cd <application-folder-name>”.

Ex: **cd AccountAPI**

Command Line Interface:

Create a Data Source using apic CLI using “**apic create --type datasource**”. Enter a data-source name and select “**Mongodb (supported by StrongLoop)**” as connector for db. Then follow the prompts to provide **host, port**. Just hit enter for the other configuration parameters. Select “**Yes**” for Install loopback-connector-mongodb.

```
C:\Srinivas\IBM projects\October Lab\account>apic create --type datasource
? Enter the data-source name: test-db
? Select the connector for test-db: MongoDB (supported by StrongLoop)
Connector-specific configuration:
? Connection String url to override other settings (eg: mongodb://username:password@hostname:port/database):
? host: XXX.XXX.XXX.XXX      Use the host and port here,
? port: XXXXXX                hit enter for the rest.
? user:
? password:
? database:
? Install loopback-connector-mongodb@^1.4 (Y/n) Y
```

API Designer:

The API Connect Designer is a GUI that allows developers to graphically create and manage their APIs. Navigate to your application folder in command line or

terminal using “**apic edit**” command. API Designer opens in a browser, Navigate to Data Sources section of API Designer. Provide details of the database to be used in the application. Use the above noted public IP address as host and port number to connect apic application to database.



5.1.5. Create API's using a swagger file

Look for “TMFOpenApi” folder of the [github repository](#) to find simplified openAPIs. These API files can be downloaded or the url from github can be used to import these APIs. These Swagger files or openAPIs are a subset of the original TMForum APIs which can be downloaded from [TM Forum Open API table](#) using this link <https://projects.tmforum.org/wiki/display/API/Open+API+Table>. The original APIs are simplified according to our selfcare app use case.

Note: For simplicity download all three .yaml files and repeat this step of importing swagger files and linking mongodb data source for all of them.

Navigate to your loopback application folder in the command line or terminal and run “**apic loopback:swagger**” to import TM Forum API into the sample application you created. Provide the File path or url of the TM Forum Open API of the github repository. Follow the prompts to select all the models and link data sources created in the above step for those respective models. Select the pre-populated data source which we created in the above step.

```
C:\Srinivas\IBM projects\TMF_Test\selfcare-account>apic loopback:swagger
? Enter the swagger spec url or file path: ../AccountManagement.yaml
Loading ../AccountManagement.yaml...
? Select models to be generated: swagger_tmf-api_accountManagement_v2_, BillingAccount
? Select the data-source to attach models to: (Use arrow keys)
> selfcare-app-db (mongodb)
  (no data-source)
```

Execution of above command creates models and links them with the datasource.

```
C:\Srinivas\IBM projects\TMF_Test\selfcare-account>apic loopback:swagger
? Enter the swagger spec url or file path: ../AccountManagement.yaml
Loading ../AccountManagement.yaml...
? Select models to be generated: swagger_tmf-api_accountManagement_v2_, BillingAccount
? Select the data-source to attach models to: selfcare-app-db (mongodb)
Creating model definition for swagger_tmf-api_accountManagement_v2_...
Creating model definition for BillingAccount...
Model definition created/updated for swagger_tmf-api_accountManagement_v2_.
Model definition created/updated for BillingAccount.
Creating model config for swagger_tmf-api_accountManagement_v2_...
Creating model config for BillingAccount...
Model config created for swagger_tmf-api_accountManagement_v2_.
Model config created for BillingAccount.
Generating C:\Srinivas\IBM projects\TMF_Test\selfcare-account\server\models\swagger_tmf-api_accountmanagement_v2_.js
Models are successfully generated from swagger spec.
Done running LoopBack generator

Updating swagger and product definitions
Created C:\Srinivas\IBM projects\TMF_Test\selfcare-account\definitions\selfcare-account.yaml swagger description
```

5.1.6. Edit Model and API

After importing the swagger file, open your apic application folder created above in windows explorer or finder in MAC. Navigate to “**server --> models**”, According to the swagger file being used, use the below table to open respective json model files:

Table 4:

Swagger File	Json data file
AccountManagement.yaml	billing-account.json
UsageConsumption.yaml (optional)	Usage-consumption-report.json
UsageManagement.yaml (optional)	usage.json

Look for the similar folder structure and open the json file in text editor.

This PC > Windows (C) > Srinivas > IBM projects > October Lab > AccountManagement > server > models				
Name	Date modified	Type	Size	
account-balance.js	10/17/2018 2:38 PM	JavaScript File	1 KB	
account-balance.json	10/18/2018 10:45	JSON File	1 KB	
billing-account.js	10/17/2018 2:38 PM	JavaScript File	1 KB	
billing-account.json	10/18/2018 10:45	JSON File	2 KB	
error.js	10/17/2018 2:38 PM	JavaScript File	1 KB	
error.json	10/18/2018 10:45	JSON File	2 KB	
money.js	10/17/2018 2:38 PM	JavaScript File	1 KB	
money.json	10/18/2018 10:45	JSON File	1 KB	
swagger-account-management.js	10/17/2018 2:38 PM	JavaScript File	4 KB	
swagger-account-management.json	10/18/2018 10:45	JSON File	1 KB	
time-period.js	10/17/2018 2:38 PM	JavaScript File	1 KB	
time-period.json	10/18/2018 10:45	JSON File	1 KB	

```

{
  "name": "BillingAccount",
  "base": "PersistedModel",
  "idInjection": true,
  "options": {
    "validateUpsert": true
  },
  "properties": {
    "paymentStatus": {
      "type": "string",
      "description": "The condition of the account, such as due, paid, in arrears."
    },
    "baseType": {
      "type": "string",
      "description": "Generic attribute indicating the base class type of the extension only when the class type of the current object is unknown to the implementation."
    }
  }
}

```

In text editor, you should be able to see a property named “**idInjection**” which is set to true by default. Change the property value to “**false**” and add a property “**forceID**” which should be set to “**false**” as well. The file should look like the image below after all the changes are done. Save it and close.

```

{
  "name": "BillingAccount",
  "base": "PersistedModel",
  "idInjection": false,
  "options": {
    "validateUpsert": true
  },
  "forceId": false,
  "properties": {
    "paymentStatus": {
      "type": "string",
      "description": "The condition of the account, such as due, paid, in arrears."
    },
    "baseType": {
      "type": "string",
      "description": "Generic attribute indicating the base class type of the extension only when the class type of the current object is unknown to the implementation."
    }
  }
}

```

Back in command explorer or terminal execute the following command “**apic loopback:refresh**” to update the changes performed above.

```

C:\Srinivas\IBM projects\October Lab\AccountManagement>apic loopback:refresh
Updating swagger and product definitions
Created C:\Srinivas\IBM projects\October Lab\AccountManagement\definitions\AccountManagement.yaml swagger description

```

Run “**apic edit**” to open the API designer. For simplicity of using and testing the APIs, let’s remove the “**security definitions**” for the API. Click the API to go into design and source of the API.



The screenshot shows the API Connect designer interface. On the left sidebar, under the 'Security' category, there are two entries: 'clientIdHeader (API Key)' and 'clientSecretHeader (API Key)'. Each entry has a small red box highlighting its delete button. Below these entries is a section titled 'Security' with the following text: 'Define security requirements for the API. Multiple alternative sets can be defined, any one of which can be selected to access the API.' Underneath this text, there is a checkbox labeled 'Option 1' followed by two checked options: 'clientIdHeader (API Key)' and 'clientSecretHeader (API Key)'. At the top right of the main content area, there is a red box highlighting the 'Save' button.

Click “**Security definitions**” on the left side and delete the “**ClientIdHeader**” and “**ClientSecretHeader**” using the delete button and click “**Save**” on the top right corner.

5.1.7. Sample input data to be inserted into database

Open a browser window and navigate to the [github repository](#) for the lab. Go to “**mongodb**” folder and download all the json files. These are sample data files to be inserted into the database.

In the next step of testing and exploring your loopback application use these json files for data while using a **POST** operation.

Table 5:

Swagger File	Json data file
AccountManagement.yaml	billingAccount.json
UsageConsumption.yaml (optional)	usageConsumptionReport.json
UsageManagement.yaml (optional)	usage.json

5.1.8. Test and Explore your Loopback application

Ensure that you are in the loopback application directory you created earlier.

Run “**cd <loopback-application>**” in your command line or terminal.

Launch the API Connect designer

Launch the API Connect designer using “**apic edit**”.
After a brief pause, the following message is displayed.
Express server listening on <http://127.0.0.1:9000/>

Start your LoopBack application

On the bottom left of the API Designer, hit the Play button to start your application.



After a short delay, your application will change to "Running".



Test and Explore your Swagger-based APIs

Now that the application is running, let's try calling some of the APIs!

On the top right of the API Designer, hit the "**Explore**" button. This takes you to an API Explorer, allowing you to explore the APIs defined in your generated Swagger doc. Let's try calling a series of these operations.

Table 6:

Swagger File	Json data file	POST operation
AccountManagement.yaml	billingAccount.json	BillingAccounts.create
UsageConsumption.yaml (optional)	usageConsumptionReport.json	UsageConsumptionReports
UsageManagement.yaml (optional)	usage.json	Usages

For each of the above swagger files while creating their own applications, use the respective POST operations from above table at this stage after clicking “**explore**” in the API designer of the application. Below POST operation describes how to post data for AccountManagement.yaml

POST /BillingAccounts:

Navigate to the operation BillingAccount.create to create a database entry. Click “**Try it**” and scroll down to the “Call Operation” button, copy data from billingAccont.json and paste it in “**data**” section and click “**Call Operation**”.

You should see a “**200 OK**” response, as well as a response body indicating that the operation was successful.

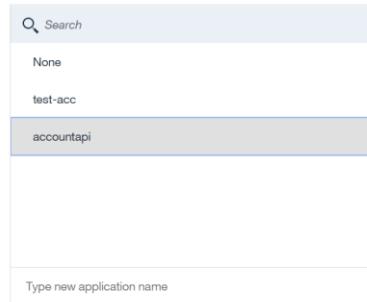
Perform similar POST operations for all the other swagger files (OpenAPI or yaml files) using respective data.

5.1.9. Publish in IBM Cloud

Publish the application using the “**Publish**” button on top right corner. Choose “**Add and Manage Targets**” and “**Add IBM Bluemix target**”. Ensure that the organization is correct (it should correspond to your Bluemix email). Choose the “**Sandbox**” catalog.

Type a new application name: “**AccountAPI**”. Click the (+) button and click “**Save**”.

Select a Bluemix application

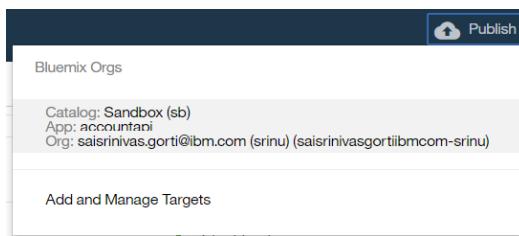


Back

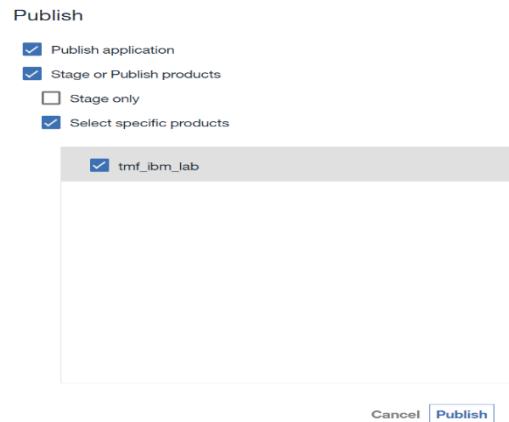
Cancel

Save

You've created a publish target, deploy it to IBM Cloud by clicking “**Publish**” button and choosing the target you just created.

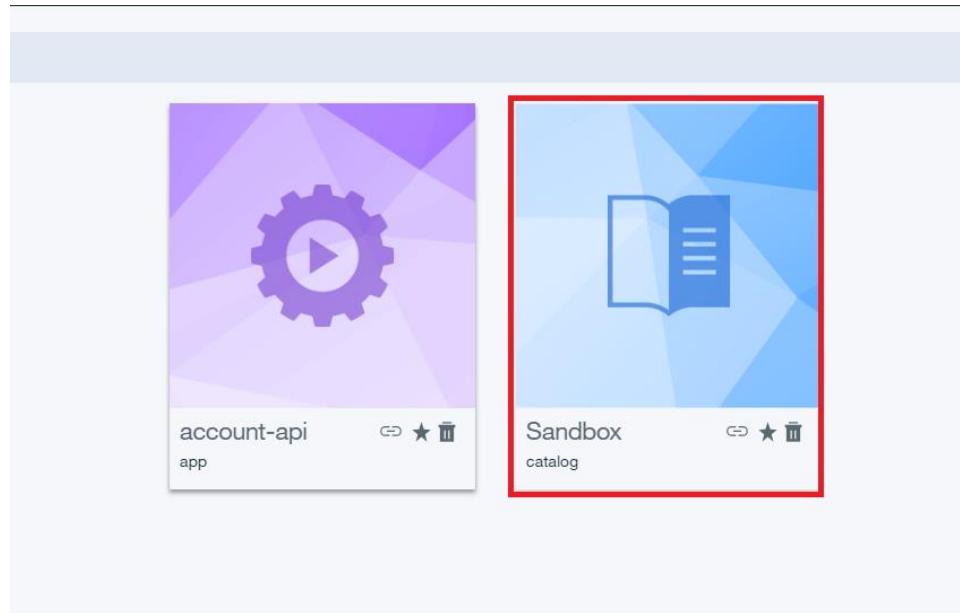


Select the below options and click “**publish**”.

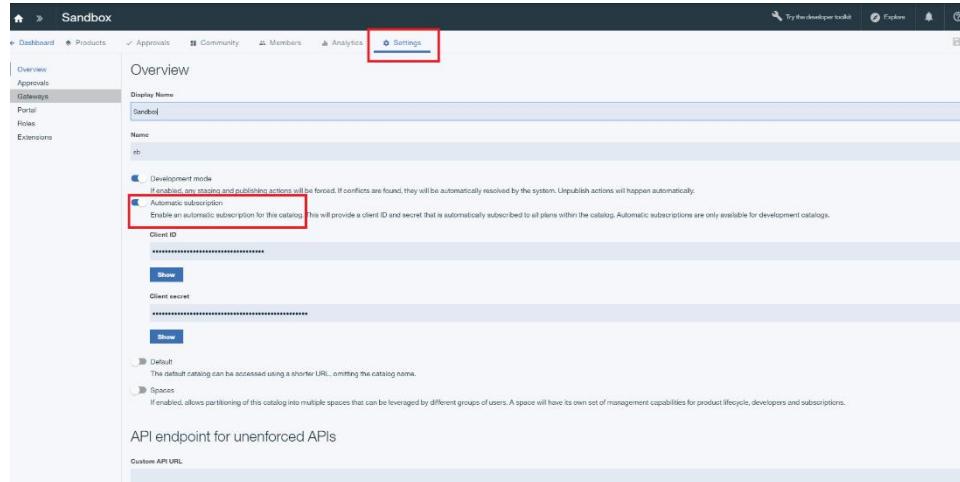


Once published and the application's state is “**started**”, the application is started and your APIs are being managed by API Connect.

Navigate to IBM Cloud dashboard using <https://console.bluemix.net> and look for the API Connect instance created. You should be able to see your catalog (sandbox) and the application which was just published to API Connect.



Click on the “**sandbox**” catalog and navigate to “**settings**” tab as shown below. Look for the “Automatic Subscription” radio button and toggle the button to turn off the automatic subscription. This enables a clientId and secret to access any URLs. To test the APIs in a simple manner let’s turn off this feature.



Now the settings tab should look like the image below. Click “**Save**” button on the right top corner to save the settings to our catalog.

The screenshot shows the 'Sandbox' catalog settings in the IBM Cloud dashboard. Under the 'Development mode' section, there is a checkbox labeled 'Automatic subscription'. This checkbox is highlighted with a red box. Below it, there is a note: 'Enable an automatic subscription for this catalog. This will provide a client ID and secret that is automatically subscribed to all plans within the catalog. Automatic subscriptions are only available for development catalogs.' Other options like 'Default' and 'Spaces' are also listed.

5.1.10. Test API getting data

Navigate to IBM Cloud dashboard using <https://console.bluemix.net> and look for the API Connect instance created. Select your catalog and click “explore” on the top right corner of the page. Select “**Sandbox**” from the catalogs to test APIs.

The screenshot shows the IBM Cloud dashboard with the 'Explore' button highlighted with a red box. Below it, the 'Catalogs' section shows the 'Sandbox' catalog selected, also highlighted with a red box.

GET /BillingAccounts:

Navigate to the operation BillingAccount.find to get a list of existing BillingAccounts. Click “**Try it**” and click “**Call Operation**”.

The screenshot shows the 'Try it' interface for the 'BillingAccount.find' operation. The 'Call operation' button is highlighted with a red box. The interface includes sections for 'Parameters', 'Type Headers', and 'Accept' (set to 'application/json').

You should see a “**200 OK**” response, as well as a response body with the list of billingAccounts indicating that the operation was successful.

5.2. Functions as a service (Serverless applications)

5.2.1. IBM Functions

IBM Cloud Functions (based on Apache OpenWhisk) is a Function-as-a-Service (FaaS) platform which executes functions in response to incoming events. Given Cloud Functions’ event-driven nature, it offers several benefits for user-facing applications, whereas the HTTP requests coming from the user’s browser serve as the events. Cloud Functions applications use compute capacity and billed only when they are serving user requests. Idle standby or waiting mode is nonexistent. This feature makes Cloud Functions considerably less expensive when compared to traditional containers or

Cloudfoundry applications. Both of which can spend most of their time idle, waiting for inbound user requests, and being billed for all that “sleeping” time.

IBM has a growing list of runtime execution options, which now includes, Java, Swift, Node, Python, PHP and other languages of your choice using Docker.

5.2.2. Access IBM Functions

Navigate to catalog.mybluemix.net to reach the IBM Cloud Catalog.
Search “**Functions**” to find IBM Functions Service.

****Note: Please make sure that the actions being created on IBM Functions as a part of this lab are on the same cloudfoundry organization and same space as the Watson assistant service created above. This way Watson assistant and IBM Functions can call each other.**

The screenshot shows the IBM Cloud Catalog interface. At the top, there's a navigation bar with 'Catalog', 'Docs', 'Support', and 'Manage' buttons. Below the navigation is a search bar with the placeholder 'Search for resource...'. The main area displays search results for 'functions'. On the left, there's a sidebar with categories like All Categories (4), Compute (1), Containers, Networking, Storage, AI, Databases (1), Analytics (1), Data Pipelines, Developer Tools, Integration, Internet of Things, Security and Identity, Starter Kits, Web and Mobile, and Web and Application (1). The 'Compute' category is expanded, showing 'Serverless Compute' and 'Functions'. The 'Functions' card is highlighted with a red box. It features an icon of a green circle with a white 'f', the text 'Functions IBM', and the description 'Execute code on demand in a highly available, serverless environment.' To the right of the Functions card is another card for 'Db2 Warehouse IBM'. At the bottom of the catalog page, there's a note: 'Try the best of the Catalog for free with no time restrictions with Lite plans. The Lite filter is enabled. Remove the filter to see the full Catalog.'

5.2.3. Get IBM Functions credentials

Navigate to “**API Key**” of Getting started menu (left hand side), Change the region to **US South** on the top. Look for the API Key section on the right having Current namespace, host and key. The hidden key (click the show key to make it visible) has the credentials of IBM Functions in the form of “**username:password**”.

The screenshot shows the 'API Key' page for IBM Cloud Functions. On the left, there's a sidebar with 'Getting Started' (selected), 'Overview', 'Pricing', 'Concepts', 'Integrations', 'CLI', 'iOS SDK' (highlighted with a red box), 'Documentation', 'Actions', 'Triggers', and 'Monitor'. At the top, there are dropdowns for 'REGION' (set to 'US South'), 'CLOUD FOUNDRY ORG' (set to 'tmiedemo@us.ibm.com'), and 'CLOUD FOUNDRY SPACE' (set to 'dev'). The main area is titled 'API Key' with a sub-section 'The IBM Cloud Functions REST API is protected with an API Key. Each Namespace has a unique API Key assigned, which needs to be provided via HTTP Basic authentication when calling any API in that Namespace, except for Web Actions invocations.' Below this, there's a table with columns 'API Key', 'NameSpace', 'CURRENT NAMESPACE', 'HOST', and 'KEY'. The 'CURRENT NAMESPACE' field contains 'tmiedemo@us.ibm.com_dev', the 'HOST' field contains 'openwhisk.ng.bluemix.net', and the 'KEY' field contains '720ze17e-bca7-41cb-b82'. There are three red arrows pointing to these fields with labels: 'To copy username and password' points to the 'CURRENT NAMESPACE' field, 'To copy username and password' points to the 'HOST' field, and 'Show key to make credentials visible' points to the 'KEY' field.

Copy and paste these credentials in a notepad or any text editor as these are required in Watson Assistant to call IBM Functions.

Table 7:

IBM Functions Namespace:	
Username:	
Password:	

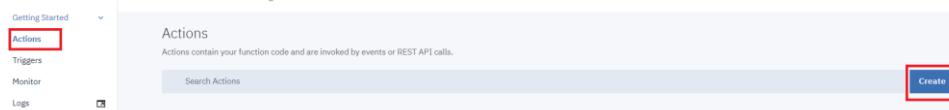
Take your namespace from above table 7 and remove ‘@’ and ‘.’ from it and replace underscore with hyphen (replace ‘_’ with ‘-’). For instance, **tmedemo@us.ibm.com dev** would be replaced as **tmedemousibmcom-dev**. Note this replaced text as API Connect namespace.

Table 8:

IBM Functions Namespace:	
Username:	
Password:	
API Connect Namespace:	

5.2.4. Create action 1 and test

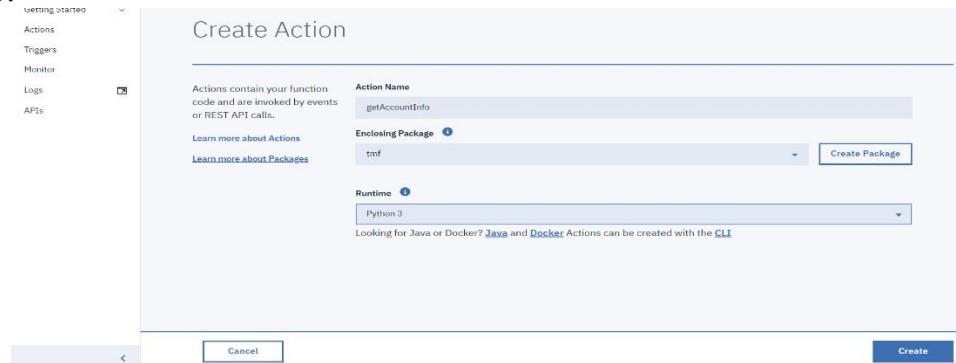
Navigate to “Actions” in the Left-hand menu. Click the Blue “Create” Button on the right-hand side and click “Create Action” to create a new action.



Enter “getAccountInfo” as the Action Name.

Click “create Package” and enter package name as “TMF”.

Select the package created above using the dropdown. Select Python 3 as your Runtime in the Dropdown Menu. Then click the “Create” Button in the lower right corner.



In a separate browser tab, navigate to: Within the Git repository, navigate to [CTA_Lab_2018/IBMFunctions/getAccountInfo.py](https://raw.githubusercontent.com/commgsc/CTA_LAB_2018/master/IBMFunctions/getAccountInfo.py). Click “Raw” and copy the code from “getAccountInfo.py”



```

import sys
import requests

def main(dict):
    response = requests.get('https://api.us.apiconnect.ibmcloud.com/tmedemousibmcom-dev/sb/api/BillingAccounts/acc111?filter={"fields":{"name":true,"state":true,"type":true,"accountBalance":true}}')
    res = response.json()
    accountbal = res['accountBalance']
    bal = accountbal[0]
    return { 'accountbal' : bal['amount']['value'], 'startdatetime' : bal['validFor']['startDateTime'], 'enddatetime' : bal['validFor']['endDateTime'] }

```

Back in your IBM Functions Tab, paste the code from the Git Repository in the “code” editor in the center of the page and click “Save”



Change API Connect endpoint:

Please perform this section only if a loopback application has been created for AccountManagement.yaml as demonstrated in section 5.1. Skip this if you haven't published loopback application to IBM Cloud.

In the above IBM Functions code, replace the text between **ibmcloud.com** and **sb** with the API Connect namespace from table 7.

For instance,

Original URL: [https://api.us.apiconnect.ibmcloud.com/tmedemousibmcom-dev/sb/api/BillingAccounts/acc111?filter={"fields":{"name":true,"state":true,"type":true,"accountBalance":true}}](https://api.us.apiconnect.ibmcloud.com/tmedemousibmcom-dev/sb/api/BillingAccounts/acc111?filter={)

Modified URL: [https://api.us.apiconnect.ibmcloud.com/*Replace with API Connect namespace from table 8*/sb/api/BillingAccounts/acc111?filter={"fields":{"name":true,"state":true,"type":true,"accountBalance":true}}](https://api.us.apiconnect.ibmcloud.com/*Replace with API Connect namespace from table 8*/sb/api/BillingAccounts/acc111?filter={)

Validating created IBM Function:

Back on the main page, Click the “Invoke” Button above the code editor in the center of the page. You can see the results of your test in the “Activations” Window shown at right in the image below:

```

1 import sys
2 import requests
3
4 def main(dict):
5     response = requests.get("https://api.us.apiconnect.ibmcloud.com/tmedemoisibcon-dev/sb/api/BillingAccounts/ac1117f")
6     accountbal = response.json()
7     accountbal['accountBalance']
8     bal = accountbal['accountBalance']
9     return ({"accountbal": bal['amount']['value']},{'startdatetime': bal['validFor']['startDateTime']},{'enddatetime': bal['validFor']['endDateTime']})
10
11
12
13
14
15
16
17
18

```

Activations

- getAccountInfo 814 ms 10/11/2018, 11:59:41

Activation ID: 512055f262534ax0ba455f28c930a2839

Results:

```

{
    "accountbal": 139.88,
    "startdatetime": "2018-04-10 00:00:00",
    "enddatetime": "2018-04-11 00:00:00"
}

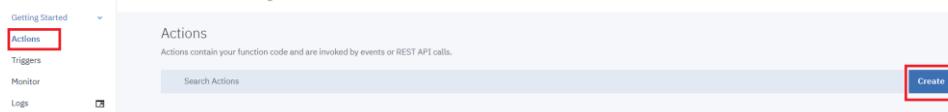
```

Logs: []

If the function is executed properly without any errors, we will be able to see results as shown above.

5.2.5. Create action 2 and test

Navigate to “Actions” in the Left-hand menu. Click the Blue “Create” Button on the right-hand side and click “Create Action” to create a new action.



Enter “**getBillingEvents**” as the Action Name. Select the package name created above using the dropdown. Select Python 3 as your Runtime in the Dropdown Menu. Then click the blue “**Create**” Button in the lower right corner.

Action Name: getBillingEvent

Enclosing Package: TMF

Runtime: Python 3

In a separate browser tab, navigate to: Within the Git repository, navigate to [CTA_Lab_2018/IBMFunctions/getBillingEvents.py](#). Click “Raw” and copy the code from “getBillingEvents.py”

```

import sys
import requests
import json,operator

def main(dict):
    response = requests.get('https://api.us.apiconnect.ibmcloud.com/tmedemousibmcom-dev/sb/api/Usages?filter={"where":{"relatedParty.role":"customer","relatedParty.id":"cst123","type":"voice","date":{"gt":"2018-04-01"}}}')
    res = response.json()
    data = []
    for item in res:
        tmp = {'UsageType': item['type']}
        for usagechar in item['usageCharacteristic']:
            tmp[usagechar['name']] = usagechar['value']
        mins = int(tmp['duration']) / 60
        cost = round(mins*float(item['ratedProductUsage'][0]['taxExcludedRatingAmount']),2)
        tmp['Cost'] = float(cost)
        tmp['duration'] = str(tmp['duration']) + ' ' + tmp['unit']
        del tmp['unit']
        del tmp['endDateTime']
        del tmp['UsageType']
        del tmp['originatingNumber']
        data.append(tmp)
    data_sorted = sorted(data, key=lambda d: d['Cost'],reverse = True)
    billing_det = json.dumps(data_sorted)
    return { 'result' : billing_det }

```

Back in your IBM Functions Tab, paste the code from the Git Repository in the “code” editor in the center of the page.

TMForumLabs/getBillingEvents Web Action

The screenshot shows the IBM Functions code editor interface. On the left, there's a sidebar with sections like Code, Parameters, Runtime, Endpoints, Connected Triggers, Enclosing Sequences, and Logs. The Code section contains the Python script provided above. The right side has a larger area for the code editor with tabs for "Code" (Python 3.6.4) and "Edit mode - press ESC to exit". The code is identical to the one in the previous block.

```

Code ❶ Python 3.6.4
Edit mode - press ESC to exit

1 import sys
2 import requests
3 import json,operator
4
5 def main(dict):
6     response = requests.get('https://api.us.apiconnect.ibmcloud.com/tmedemousibmcom-dev/sb/api/Usages?filter={"where":{"relatedParty.role":"customer","relatedParty.id":"cst123","type":"voice","date":{"gt":"2018-04-01"}}}')
7     res = response.json()
8     data = []
9     for item in res:
10        tmp = {'UsageType': item['type']}
11        for usagechar in item['usageCharacteristic']:
12            tmp[usagechar['name']] = usagechar['value']
13        mins = int(tmp['duration']) / 60
14        cost = round(mins*float(item['ratedProductUsage'][0]['taxExcludedRatingAmount']),2)
15        tmp['Cost'] = float(cost)
16        tmp['duration'] = str(tmp['duration']) + ' ' + tmp['unit']
17        del tmp['unit']
18        del tmp['endDateTime']
19        del tmp['UsageType']
20        del tmp['originatingNumber']
21        data.append(tmp)
22    data_sorted = sorted(data, key=lambda d: d['Cost'],reverse = True)
23    billing_det = json.dumps(data_sorted)
24    return { 'result' : billing_det }

```

Validating created IBM Function:

Back on the main page, Click the “Invoke” Button above the code editor in the center of the page. You can see the results of your test in the “Activations” Window shown at right in the image below:

The screenshot shows the main IBM Functions interface. At the top, there's a navigation bar with icons for back, forward, and search. Below it is a search bar with the URL https://raw.githubusercontent.com/commgsc/CTA_LAB_2018/master/IBMFunctions/getBillingEvents.py. The main area has sections for Code, Parameters, Runtime, Endpoints, Connected Triggers, Enclosing Sequences, and Logs. To the right, there's a large "Code" editor with the same Python script. Below the editor is a "Logs" section which is currently empty. On the far right, there's a "Activations" window. It shows a single entry for the "getBillingEvents" function, which was invoked on 10/11/2018 at 12:00:50. The activation ID is ddccb0ff5e642b4bc80bf5eb2b454. The result of the invocation is displayed as a JSON object:

```

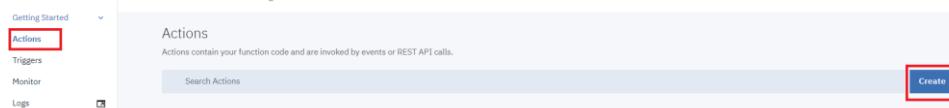
{
  "result": "[{"destinationNumber": "+919876543211", "duration": "3540 sec", "startDateTime": "2018-04-07 14:02:17", "Cost": 8.2}, {"destinationNumber": "+919876543210", "duration": "3540 sec", "startDateTime": "2018-04-08 00:02:25", "Cost": 0.59}, {"destinationNumber": "+919876543211", "duration": "3540 sec", "startDateTime": "2018-04-08 16:42:25", "Cost": 0.02}, {"destinationNumber": "+919876543210", "duration": "3 sec", "startDateTime": "2018-04-09 00:12:11", "Cost": 0.01} ]"
}

```

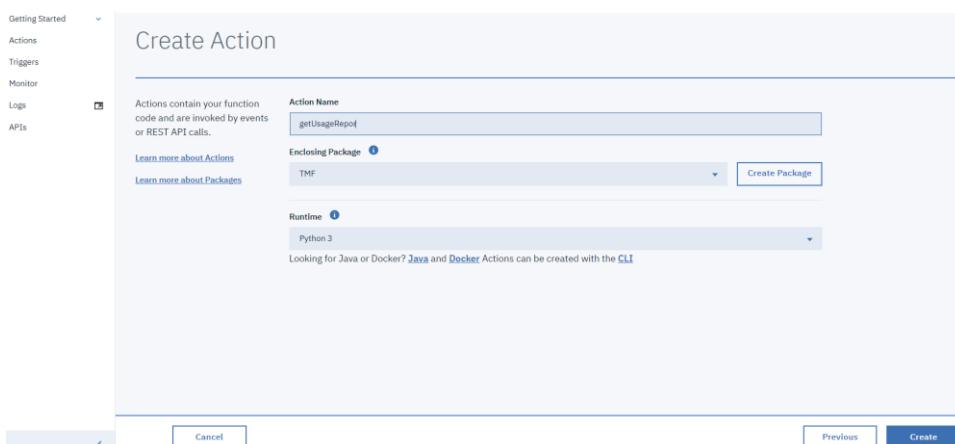
If the function is executed properly without any errors, we will be able to see results as shown above.

5.2.6. Create action 3 and test

Navigate to “Actions” in the Left-hand menu. Click the Blue “**Create**” Button on the right-hand side and click “Create Action” to create a new action.



Enter “**getUsageReport**” as the Action Name. Select the package name created above using the dropdown. Select Python 3 as your Runtime in the Dropdown Menu. Then click the blue “**Create**” Button in the lower right corner.



In a separate browser tab, navigate to: Within the Git repository, navigate to [CTA_LAB_2018/IBMFunctions/getUsageReport.py](https://raw.githubusercontent.com/gsc/CTA_LAB_2018/master/IBMFunctions/getUsageReport.py). Click “Raw” and copy the code from “getUsageReport.py”

A screenshot of a browser window displaying the raw code of 'getUsageReport.py'. The URL in the address bar is 'https://raw.githubusercontent.com/gsc/CTA_LAB_2018/master/IBMFunctions/getUsageReport.py'. The code itself is a Python script that uses requests and json libraries to interact with an API endpoint to retrieve usage consumption reports.

```
import sys
import requests
import json
import datetime

def main(dict):
    response = requests.get('https://api.us.apiconnect.ibmcloud.com/tmedemousibmcom-dev/sb/api/UsageConsumptionReports?filter={"where":{"bucket.product_id":"mobile999"}}')
    res = response.json()
    buckets = res[0]['bucket']
    data = []
    for bucket in buckets:
        print(bucket)
        tmp = {'UsageType': bucket['usageType']}
        tmp['Usage'] = bucket['bucketCounter'][0]['value']
        tmp['Balanceleft'] = str(bucket['bucketBalance'][0]['remainingValue']) + ' ' + bucket['bucketBalance'][0]['unit']
        data.append(tmp)
    usage_det = json.dumps(data)
    return { 'result':usage_det }
```

Back in your IBM Functions Tab, paste the code from the Git Repository in the “code” editor in the center of the page.

TMF/getUsageReport Web Action

Code Python 3.6.4

Change Input

Invoke

Code

Parameters

Runtime

Endpoints

Connected Triggers

Enclosing Sequences

Logs

```
1 import sys
2 import requests
3 import json
4 import datetime
5
6 def main(dict):
7     response = requests.get("https://api.us.apiconnect.ibmcloud.com/tmdedemoilcon-dev/sh/api/imageConsumptionReports?filter={"shares": [{"bucket.product_id": "mobile@999"}]}")
8     result = response.json()
9     buckets = result['buckets']
10    data = []
11    for bucket in buckets:
12        print(bucket)
13        usage_type = bucket['usageType']
14        tmp_usage = bucket['bucketCounters'][0][8]['value']
15        tmp_balance = bucket['bucketCounters'][0][8]['remainingValue']
16        unit = bucket['unit']
17        usage_det = {
18            'usage_type': usage_type,
19            'usage_det': json.dumps(data)
20        }
21        return {'result': usage_det}
```

Validating created IBM Function:

Back on the main page, Click the “Invoke” Button above the code editor in the center of the page. You can see the results of your test in the “Activations” Window shown at right in the image below:

TMF/getUsageReport Web Action

Code	Code (Python 3.6.4)	Change Input	Invoke
Parameters	<pre>1 import sys 2 import requests 3 import json 4 import datetime 5 6 def main(dict): 7 response = requests.get("https://api.us.apiconnect.bmccloud.com/tmfdemo/tmcn-on-dev/api/UsageConsumptionReports?<param>") 8 res = response.json() 9 buckets = res[0]['buckets'] 10 data = {} 11 for bucket in buckets: 12 if bucket['usageType'] == 'voice': 13 tag = 'usageType_voice' 14 tagValue = 'voice' 15 tagBalancedLeft = str(bucket['balanceValue']) + '[' + str(bucket['remainingValue']) + ']' + str(bucket['unit']) 16 data.append(tag) 17 usage = tag + tagValue 18 return { result:usage,data }</pre>		
Runtime			
Endpoints			
Connected Triggers			
Enclosing Sequences			
Logs			

Activations

Activations	Collapse	Clear
<p>✓ getUsageReport 749 ms 10/11/2018, 12:01:41</p> <p>Activation ID: 1014ab7a9964ef18ca8b7a9968ef1ab</p> <p>Results:</p> <pre>{"result": [{"UsageType": "voice", "Usage": 2079, "Balance": 225}, {"UsageType": "data", "Usage": 0, "Balance": 225}, {"UsageType": "sms", "Usage": 0, "Balance": 200}], "data": [{"tag": "usageType_voice", "value": "voice"}, {"tag": "tagValue", "value": "voice"}, {"tag": "tagBalancedLeft", "value": "2079 [225]"}]}</pre>		

If the function is executed properly without any errors, we will be able to see results as shown above.

5.3. AI powered chatbot

5.3.1. Watson Assistant

Watson Assistant is a robust platform that allows developers and non-technical users to collaborate on building conversational AI solutions. Its graphical UI, powerful NLP and familiar developer features allow the rapid creation of anything from simple chatbots to complex enterprise grade solutions for customer service and more. With the IBM Watson Assistant service, you can build a solution that understands natural-language input and uses machine learning to respond to customers in a way that simulates a conversation between humans.

5.3.2. Creating a workspace by uploading a JSON

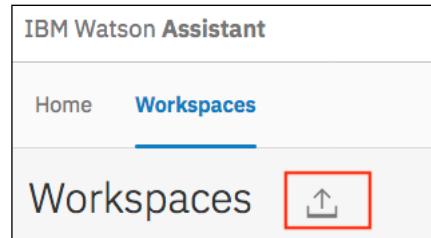
In a separate browser window navigate to the below githib link and download 'WA_CTA.json' or copy the content to create a file with json extension.

Github link:

https://raw.githubusercontent.com/commgsc/CTA_LAB_2018/master/WatsonAssistant/WA_CTA.json

Navigate to <https://console.bluemix.net/> and look for the watson assistant created in section 4.6. Select your watson assistant from the services and click “**Launch Tool**” to launch your workspaces.

Click “**Workspaces**” and import “**WA_CTA.json**” file (json downloaded from the github repository) using the import button as shown below.



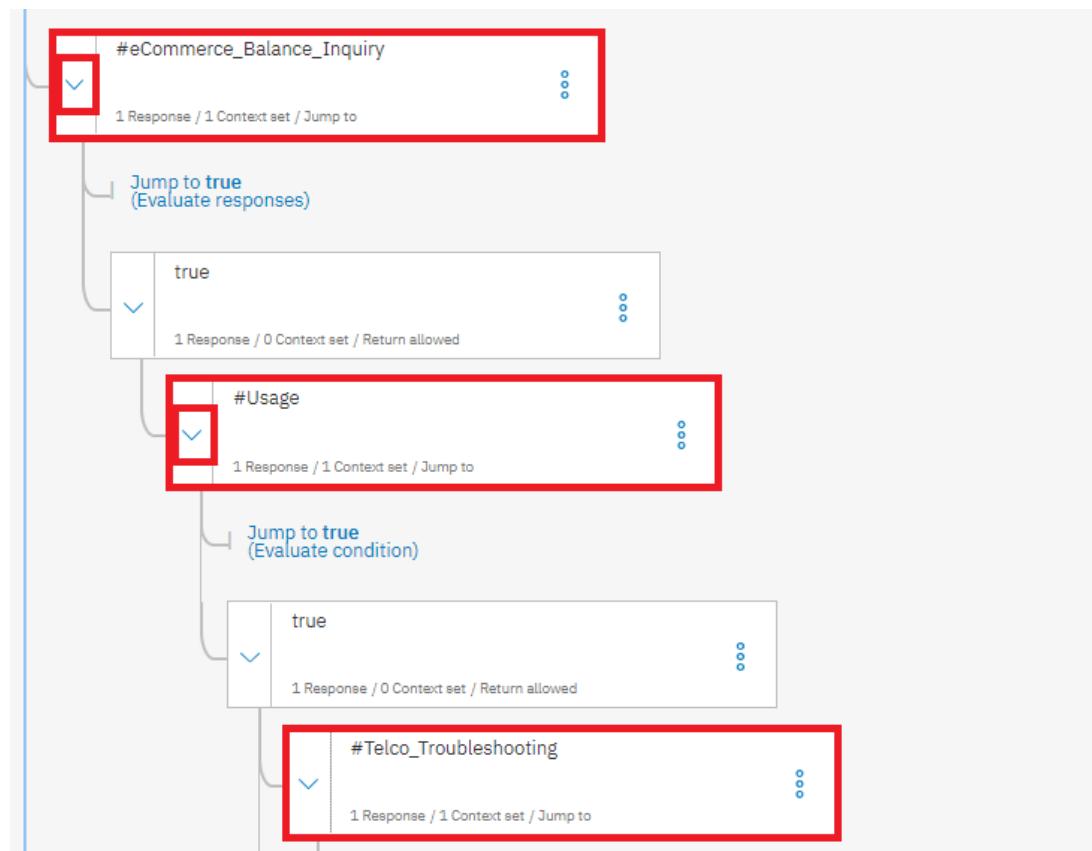
Once json file has been imported, you could view ‘Intents’, ‘Entities’ and ‘Dialog’.

5.3.3. Edit the dialog Nodes to point to the correct IBM Functions

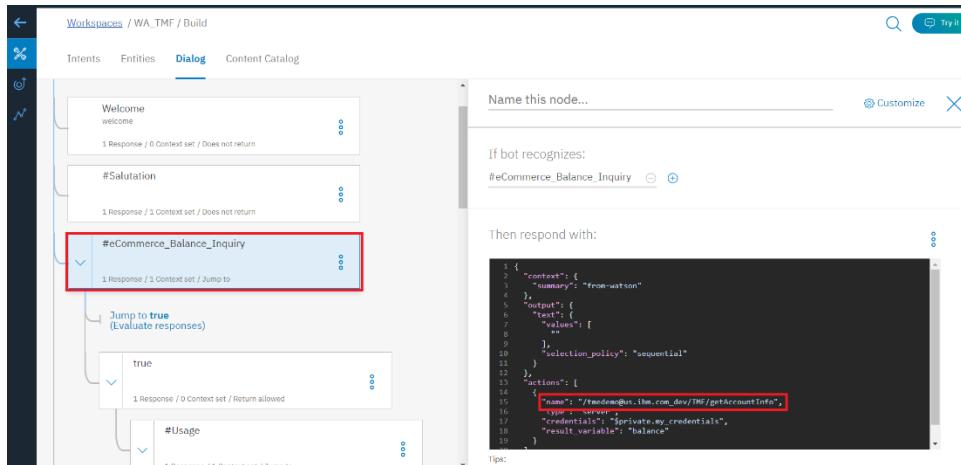
Once the workspace is imported, click on the workspace and then click on “**Dialog**”.

Look for the below intents in the dialog and expand by clicking the arrow as shown below.

- #eCommerce_Balance_Inquiry
- #Usage
- #Telco_Troubleshooting



For each of the above 3 intents, look for the attribute “**name**” in “**actions**”, this name defines which IBM Function to be called when bot recognizes this intent. The format of functions should be “**Namespace/package/function_name**”.



The above image shows the node with intent “#**eCommerce_Balance_Inquiry**”, and on the right side you could see that this node calls “**getAccountInfo**” function of package “**TMF**” and namespace “**tmedemo@us.ibm.com_dev**”. Replace these IBM Function credentials to namespace noted down in **section 5.2.3 (Table 7)** and package created in **section 5.2.4**. Note that it should match the format of IBM Functions defined above.

For instance,

Original action:

“name”: “[/tmedemo@us.ibm.com_dev/TMF/getAccountInfo](#)”

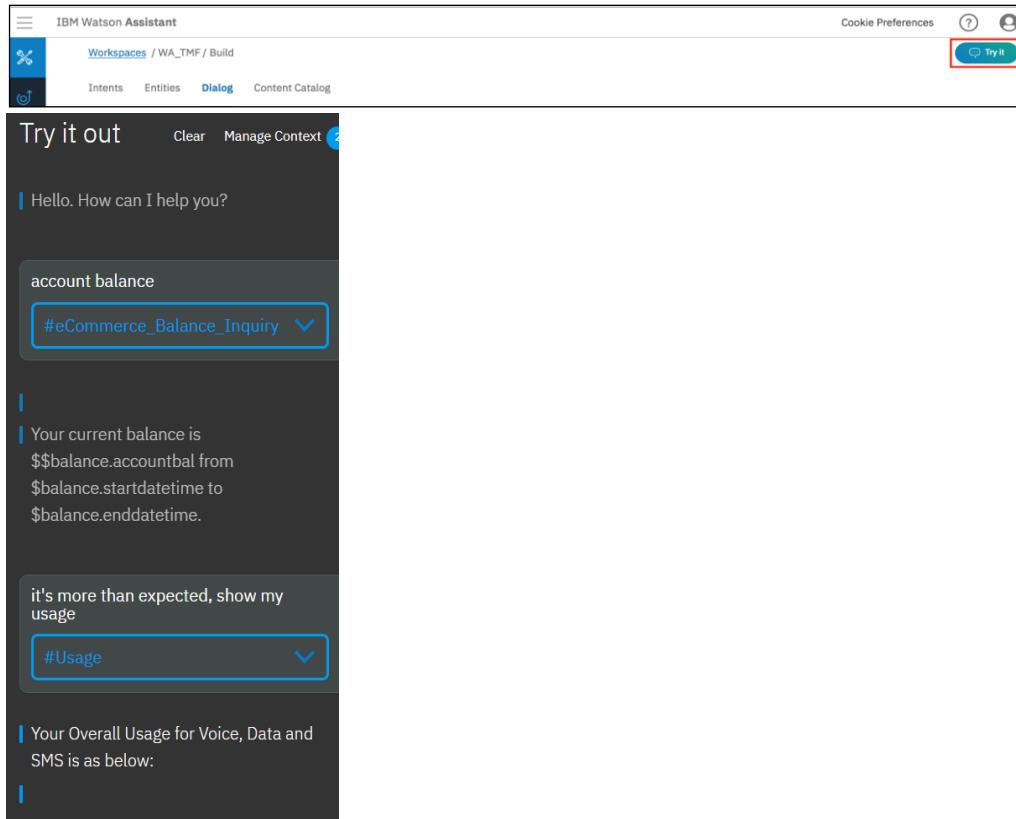
Modified action:

“name”: “[/*Namespace from table 7*/TMF/getAccountInfo](#)”

Assuming that names of the IBM Functions are not changed, Change these credentials(namespace and package) for all the 3 nodes shown above.

5.3.4. Test the robot

Try out the conversation, you just created! As the credentials were not provided in the WA, we will not be able to see the actual results but when invoked through the node-red application, credentials would be provided through the application, so that we can see actual results on web application UI.



5.4. Interfacing with the end user

5.4.1. Node-red UI

Node-RED is a powerful tool for building Internet of Things (IoT) applications with a focus on simplifying the ‘wiring together’ of code blocks to carry out tasks. It uses a visual programming approach that allows developers to connect predefined code blocks, known as ‘nodes’, together to perform a task. The connected nodes, usually a combination of input nodes, processing nodes and output nodes, when wired together, make up a ‘flows’.

Node-RED provides a browser-based flow editor, which can be used to create JavaScript functions. Elements of applications can be saved or shared for re-use. The runtime is built on Node.js. The flows created in Node-RED are stored using JSON.

5.4.2. Navigate to Node-Red flow editor

User submits an input using node-red application UI, a http request is made which calls the JavaScript node of node-red flow to make an ajax call to Watson assistant. Watson assistant will call respective IBM Function in its context and sends a response either as a text message or an object. This response is processed by the JavaScript and response sent back using HTML template.

Navigate to IBM Cloud dashboard using this link <https://console.bluemix.net/>.
Click on your cluster in the clusters section.
Click “Worker Nodes” tab to note your public IP.

The screenshot shows the 'Worker Nodes' section of the Kubernetes Dashboard. It lists one node named 'w1' with a status of 'Normal'. The 'Public IP' column for this node is highlighted with a red box. The top right corner of the dashboard interface is also highlighted with a red box.

Launch “Kubernetes Dashboard (Beta)”. Navigate to services and get the port number for nodered-app as shown below.

The screenshot shows the 'Services' page for the 'nodered-app' service. It displays the 'Details' and 'Endpoints' sections. In the 'Endpoints' section, there is a table with columns: Host, Ports (Name, Port, Protocol), Node, and Ready. One entry shows 'Host: 172.30.0.110', 'Ports: nodered-app-port, 1880, TCP', 'Node: 10.47.87.245', and 'Ready: true'. Below this, the 'Pods' section shows a table with columns: Name, Node, Status, Restarts, Age, CPU (cores), and Memory (bytes). One pod entry is highlighted with a red box, showing 'Name: nodered-app-78f78c77ct', 'Node: 10.47.87.245', 'Status: Running', 'Restarts: 0', 'Age: 2 days', 'CPU (cores): 0', and 'Memory (bytes): 92.512 Mi'.

Use the Public IP and port number in the format below to access the node red application.

Node-red Flow editor:

Url - Public IP: port (Ex: 184.172.214.2:32323)

This url opens the node-red application with a pre-defined flow.

Node-red Application UI:

Url - Public IP: port/bot (Ex: 184.172.214.2:32323/bot).

This url opens up the node-red application UI which is integrated with the pre-defined configuration for watson assistant, IBM functions.

Table 8:

Public IP (host):	
Port:	

5.4.3. Change credentials (optional)

This section helps you to change credentials in Watson assistant and IBM Functions to match with the services which were created in sections 5.2, 5.3. The pre-defined node-red flow has credentials embedded in it, this runs as such without changing any credentials.

So, skip this part if you don't want to change the credentials. But for the node-red to use the services that you just created in the above sections, IBM Functions and Watson Assistant credentials have to be changed in the existing flow.

Open the node-red flow editor using **ip:port** listed in table 5. Change the IBM Functions credentials by double clicking on “**Change credentials here**” node to open the node and change the username and password to the credentials noted down in [step \(2\) of section 5.2.3](#).

Change the Watson Assistant credentials by double clicking on “**My Bot**” node to open the node and change the username, password and Workspace_ID to the credentials noted down in [step \(2\) of section 4.7](#).

If you want to use your own deep learning model to estimate facial age, follow these steps:

Click on services in your Kubernetes dashboard as shown below:

Name	Labels	Pods	Age	Images
mongodb-sandbox	app: sandbox-nodered tier: backend	1 / 1	3 days	mongo:latest
nodered-app	app: sandbox-nodered tier: frontend	1 / 1	3 days	tomyogms/noderedapp:v1
my-facial-age-estimator	app: my-facial-age-estimator	1 / 1	6 days	tomyogms/facial-age-v1

Click on the max-facial-age-estim service as shown below.

Name	Labels	Cluster IP	Internal endpoints	External endpoints	Age
mongo	tier: backend	172.21.243.43	mongo:27017 TCP mongo:31379 TCP	-	3 days
nodered-app	app: sandbox-node. tier: frontend	172.21.232.89	nodered-app:1880 TCP nodered-app:30243 TCP	-	3 days
max-facial-age-estim	-	172.21.77.72	max-facial-age-estim max-facial-age-estim	-	6 days
kubernetes	component: apiser.. provider: kubernetes	172.21.0.1	kubernetes:443 TCP kubernetes:0 TCP	-	13 days

Obtain the public port for the service

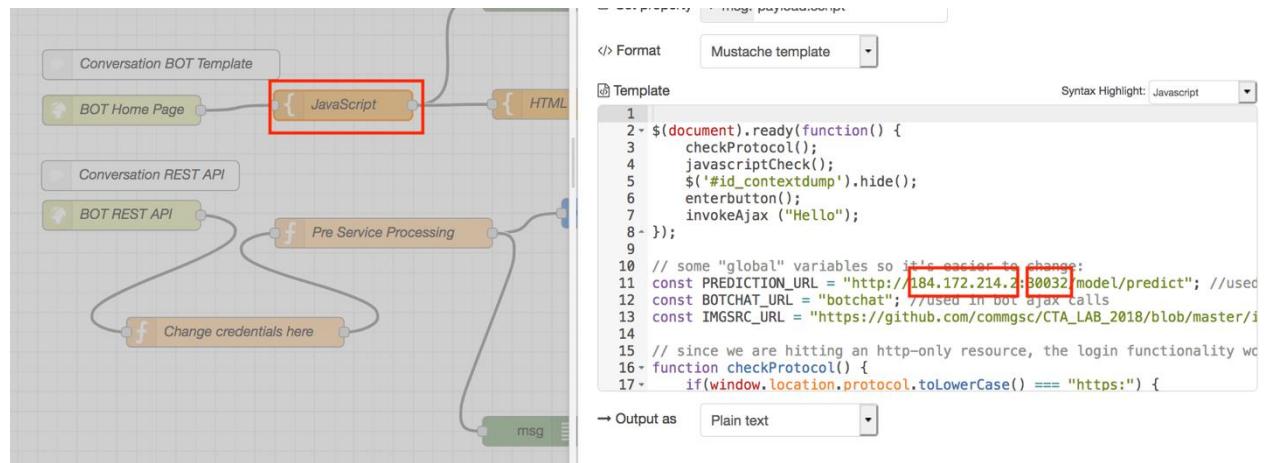
The screenshot shows the Kubernetes Services page. The service 'max-facial-age-estimator' is selected. The 'Details' section shows the following information:

- Name: max-facial-age-estimator
- Namespace: default
- Creation Time: 2018-10-12T15:24 UTC
- Label selector: app: max-facial-age-estimator
- Type: NodePort
- Session Affinity: None
- Connection: Cluster IP: 172.21.77.72
- Internal endpoints: max-facial-age-estimator:5000 TCP
max-facial-age-estimator:30032 TCP

The 'Endpoints' section shows the following table:

Host	Ports (Name, Port, Protocol)	Node	Ready
172.30.0.114	<unset>, 5000, TCP	10.47.87.245	true

Now go back to the node red flow and update the javascript node as shown below. Update the “PREDICTION_URL” variable with the public IP of your cluster and the port number you obtained from the above screenshot.



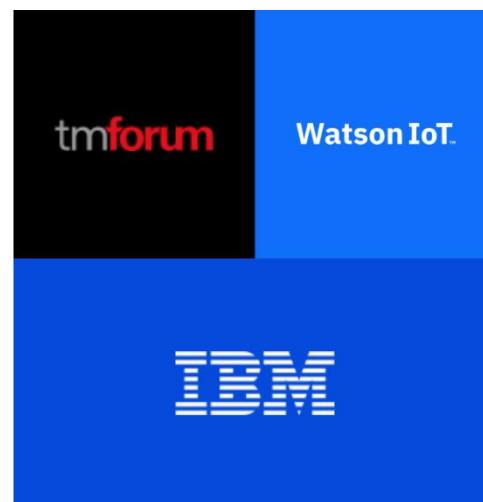
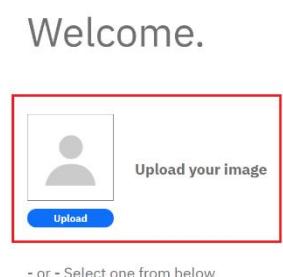
Click save and then click “**Deploy**” on the top right corner of the page. After the successful deployment, “Successfully deployed” alert would be. At this point the application is successfully deployed on IBM Cloud.

5.4.4. Access the UI and test the use case

Node-red flow editor opens up the node-red flow where individual nodes can be updated, whereas node-red application UI can be accessed using node-red application UI link from the above section 5.4.2.

Refer to above section 5.4.2 to copy the url of the application UI. Open a new browser tab, paste the url and press enter to launch the node-red application.

The selfcare node red application has a facial age detection model as its first step. This model takes image of a human being as an input to predict his/her age and then re-directs you to selfcare app. Please upload your image using the “**upload**” button or click anywhere in that area to upload an image or you can select the pre-populated images.



Once you upload your picture or select an image from the list, it takes you to next screen where the bot can assist you in self-care app instructions.

Try some inputs like “**account balance**” or “**show usage**” to initiate a conversation. These instructions will trigger intents in Watson assistant dialog which would call IBM Functions within the Watson Assistant you just created.

The screenshot shows a chat interface with the title "TMForum BOT". The conversation history is as follows:

- User: Welcome to the TM Forum bot
Bot: 2:59:43 PM
- User: By my best guess, it looks like you're only 24 years young! How may I help you?
Bot: 3:14:53 PM
- User: Your current balance is \$139.88 from 2018-04-01 00:00:00 to 2018-04-30 00:00:00.
Bot: 3:35:04 PM
- User: account balance
Bot: 3:35:03 PM
- User: show usage
Bot: 3:35:05 PM
- User: Your Overall Usage for Voice, Data and SMS is as below:

UsageType	Usage	Balanceleft
voice	2879	121 sec
data	799	225 MB
sms	0	200 sms

User: I didn't know my voice usage was too high, how much did you charge for voice?
Bot: 3:35:07 PM
- User: Your top voice charges for this month are as below:

destinationNumber	duration	startDateTime	Cost
447987654321	3540 sec	2018-04-07 14:02:17	82.01
447987653111	102 sec	2018-04-08 20:02:23	0.59
447987654321	20 sec	2018-04-05 16:42:23	0.02
447987654321	5 sec	2018-04-07 18:12:17	0

User: Type here
Bot: Submit