IBM Asset Cognitive Autonomous Racer

Building a secured and trusted framework for healthcare systems

August 17, 2021

IBM Services
Asset Community

IBM Academy of
Technology

IBM Center for
Advanced Studies

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Architect, Lead, Chicago CAS
Lead, Asset Portfolio Strategy,
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IBM Asset Cognitive Autonomous Racer

Mentors

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Sudhakar Nagarajan is a principal Software Engineer at IBM Research Triangle Park (RTP), working as a customer success manager primarily focusing on building complex architecture by applying Cloud transformation and solutions with IBM Cloud paks on Redhat Open Shift. He is innovative, talented, hands-on, self-driven, and results-oriented. He has a proven track record as a Software Engineering professional with 20+ years of IT industry experience and substantial experience in software development and other areas in various industries. He has performed multiple roles such as Technical Development Manager, Solution Architect, Software Consultant, Team Lead, and Developer.

Arunava (Ron) Majumdar

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Architect, Emerging Technology,
Lead, Asset Portfolio Strategy,
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IBM Watson and Cloud Platform

in @arunavaibm   @arunavaibm

Arunava (Ron) Majumdar is a Watson and Cloud architect with over 20 years of experience in Software design and development. He leads the Asset Portfolio Strategy for the IBM Watson and Cloud Platform and is the lead for the Chicago Center for Advanced Studies. He has been involved with large scale design, architecture and implementation for IBM clients, helping them successfully through the project lifecycle. He has architected High Availability and Disaster Recovery solutions with IBM integration products and worked on performance testing and securing client environments.

Ron started as a software engineer working with Object Oriented Programing languages, Middleware integration technologies and Relational Databases. He is currently working on Watson services, Internet-of-Things, Micro-services, API Economy, Hybrid Integration and Pattern-based automation. He is deeply involved with moving workloads to the cloud and Application Modernization. Ron has several patents and published assets to his credit and is collaborating with Research faculty and Universities on innovative ideas and their implementations with emerging technologies. He is also leading several efforts for a comprehensive innovation strategy for IBM in the Greater Chicago area.

CAR Design

Designing a Open and Secured framework for Autonomous Racing Car

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Abstract

Most racing car scenarios are built with manual racing controls. This project is aimed at autonomous racing using advanced Machine Learning and Deep Learning algorithms.

Racing cars have always tested the limits of our understanding of path optimizations along with acceleration and declaration of the vehicle on a winding track. Once multiple racing cars are introduced the driver of the vehicle has to not only optimize the path but avoid any obstacles (cars) in the path. This make it a very complex problem to solve for an autonomous vehicle. This project aims to take up this challenge in a phased approach.

Phase I (completed):
Construct a scaled down version of the car. Use the Open Source NVDIA project to build an autonomous racing car using Tamya TT02 model and Jetson Nano.

https://github.com/NVIDIA-AI-IOT/jetracer

Train and follow the road. Train the car on an oval track.

Phase II:
Connect to the Proximity Network using MQ protocol to the MQ Queue Manager. Build an application to connect to the Watson IoT Platform to transfer data to be analyzed. Multiple cars should be able to connect to this server and publish information. On the IBM Cloud the data can then be stored on Cloud Object Storage bucket. Use Watson Studio and Isaac Sim to build and train models using the data obtained after every run. Build alternate models using Studio and use Auto AI to check which models work better. Create a pipeline of the models to be deployed to the racing car.

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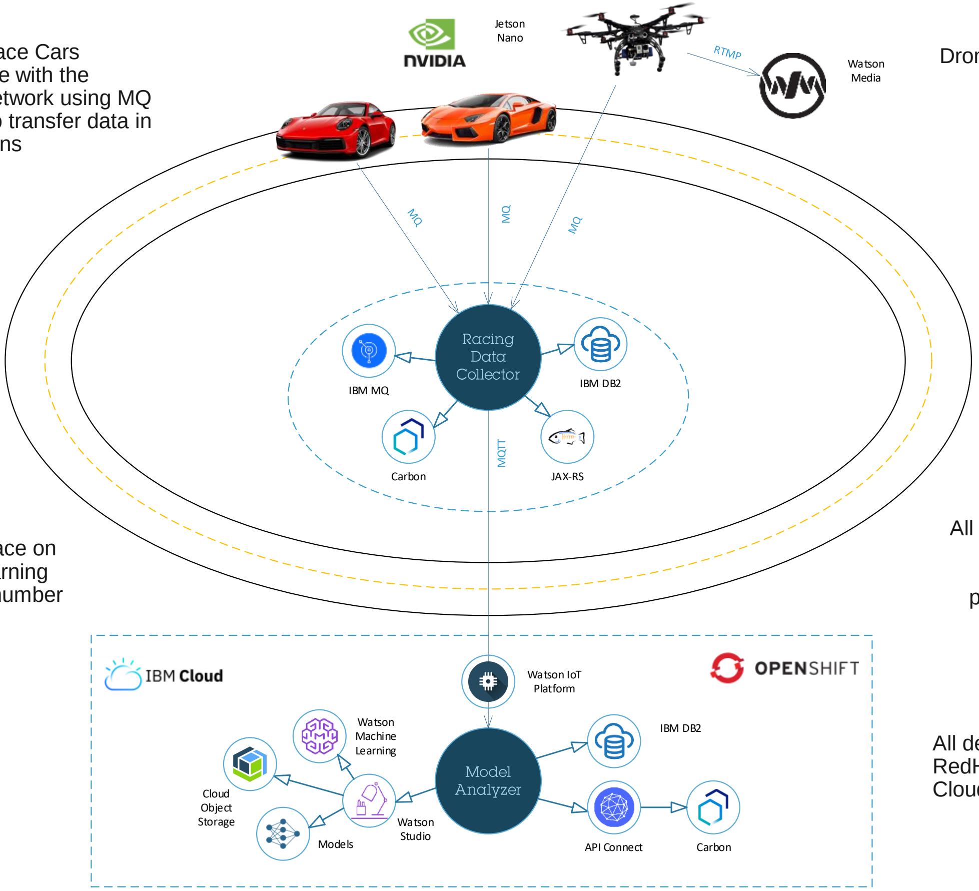
Individual Race Cars communicate with the Proximity Network using MQ Clustering to transfer data in both directions

Race cars learn about the track by driving around the track several times within the boundaries of the lines or walls identified.

Race cars may be trained by experts through remote controlled driving and by analyzing tracks through algorithms for path optimization

Race cars must also race on untrained tracks by learning the track for a limited number of test runs

Data and models will be analyzed on the IBM Cloud using Watson Studio, Isaac Sim and related services



Drones can identify, follow, report driving data and stream video

Data captured at the proximity network can be subscribed to by the racing team and the spectators

Racing teams will be able to analyze, retrain and deploy models after each race on known tracks

All the data, code, hardware details and designs will be available as Open Source for academic purposes and preparation for the competition for the next season after the final races are completed.

All deployments will be on RedHat OpenShift on the IBM Cloud

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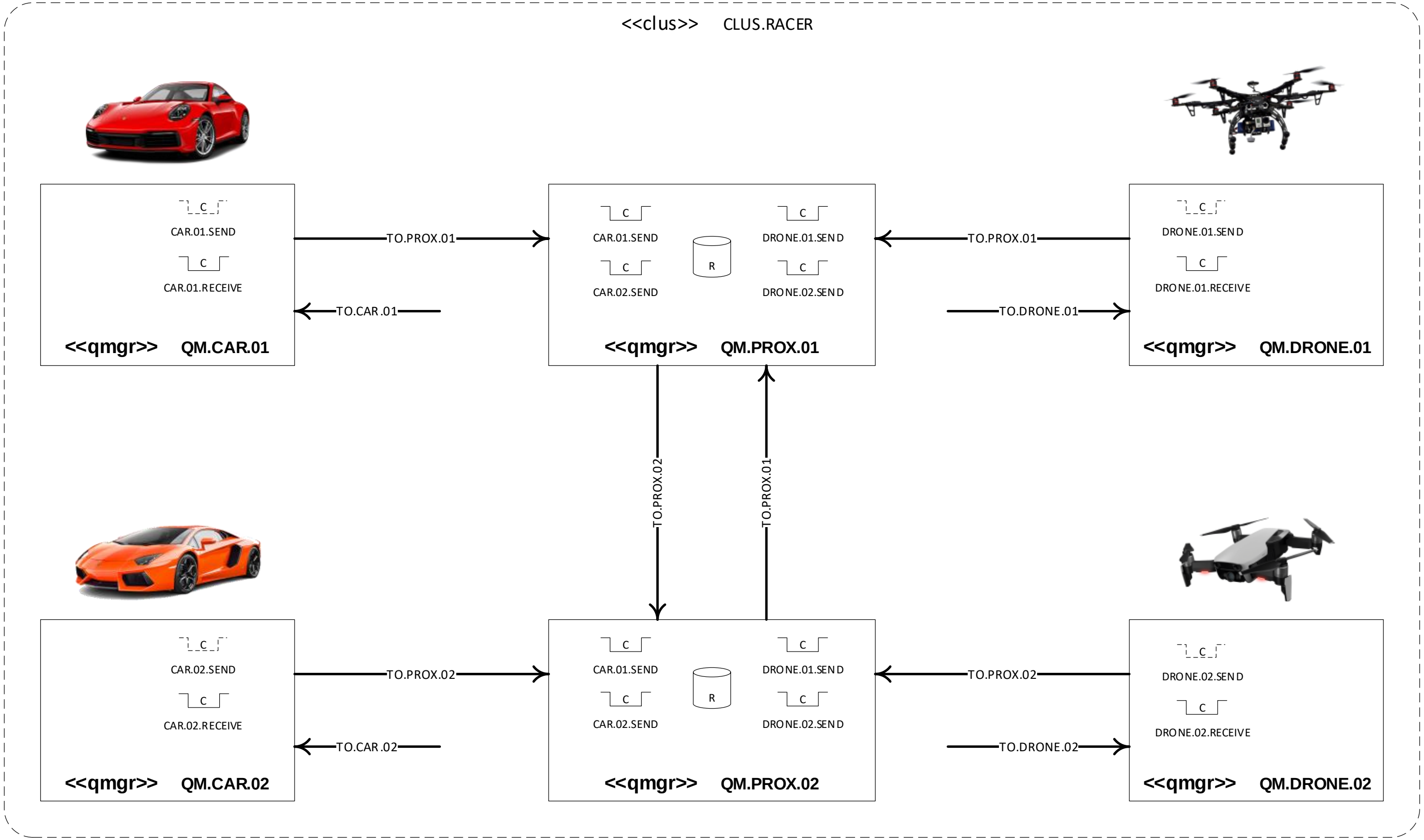
MQ Proximity Cluster



<<clus>> CLUS.RACER

<<qmgr>> QM.CAR.01

- C CAR.01.SEND
- C CAR.01.RECEIVE

TO.PROX.01

TO.CAR.01

<<qmgr>> QM.PROX.01

- C CAR.01.SEND
- C CAR.02.SEND
- R
- C DRONE.01.SEND
- C DRONE.02.SEND

TO.PROX.01

TO.DRONE.01

<<qmgr>> QM.DRONE.01

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- C DRONE.01.RECEIVE

TO.PROX.02

TO.PROX.01

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- C CAR.02.RECEIVE

TO.PROX.02

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- C CAR.02.SEND
- R
- C DRONE.01.SEND
- C DRONE.02.SEND

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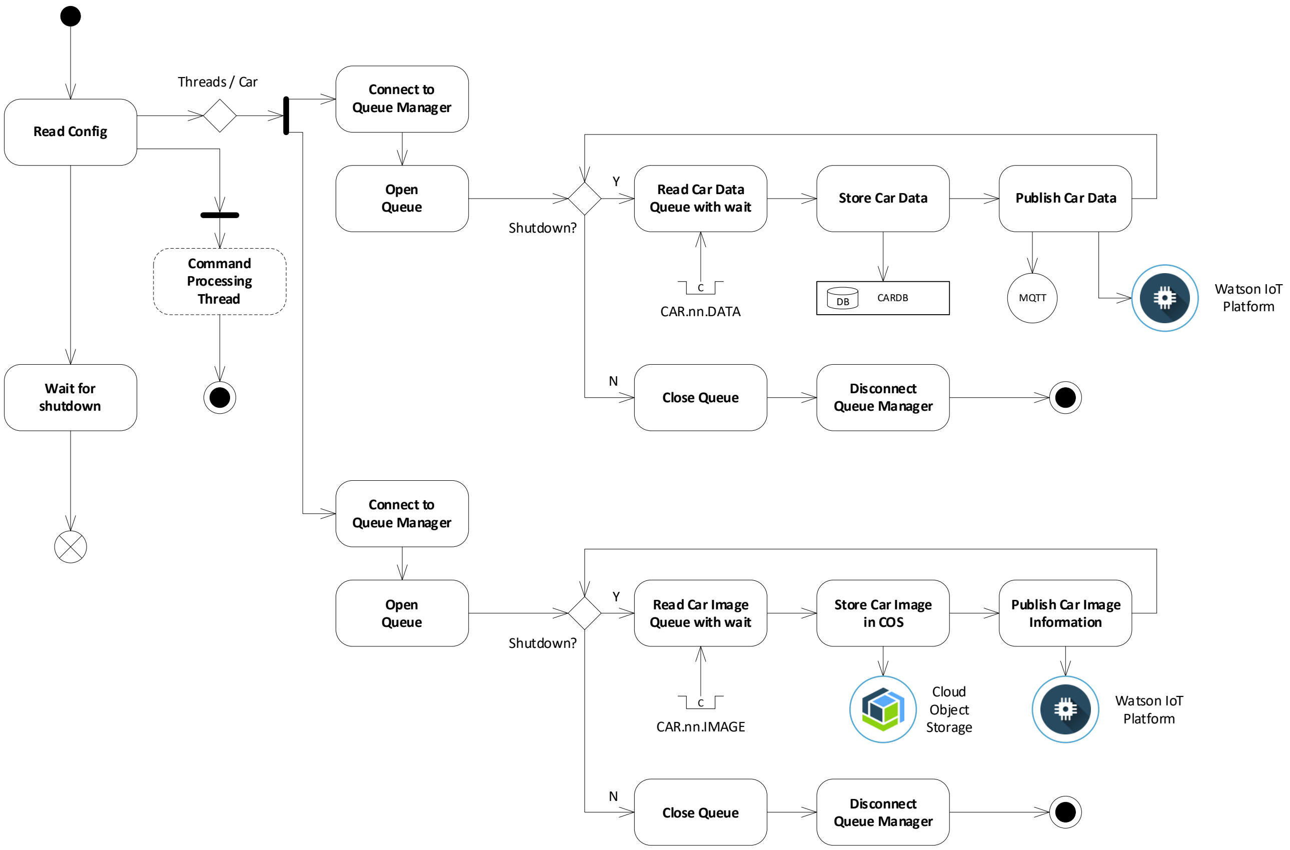
<<qmgr>> QM.DRONE.02

- C DRONE.02.SEND
- C DRONE.02.RECEIVE

IBM Asset Cognitive Autonomous Racer



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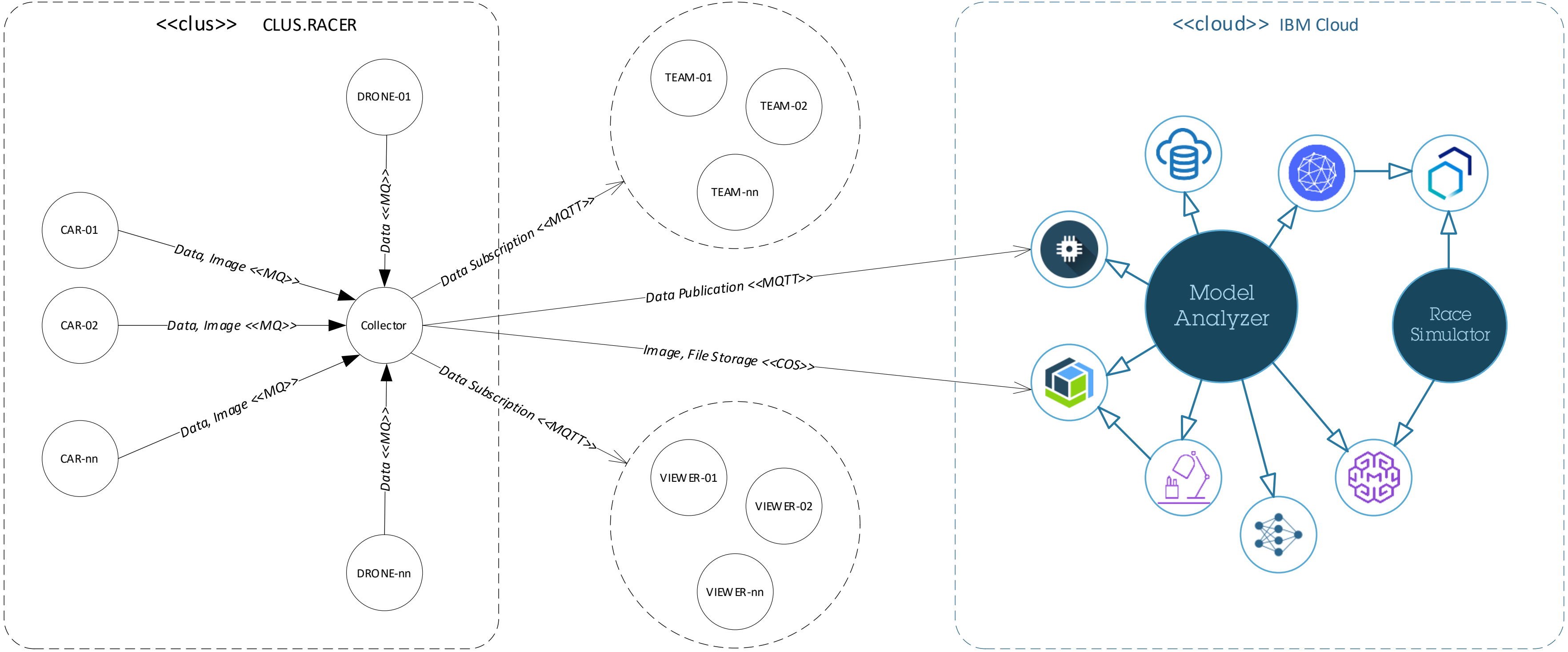
Hybrid Interaction



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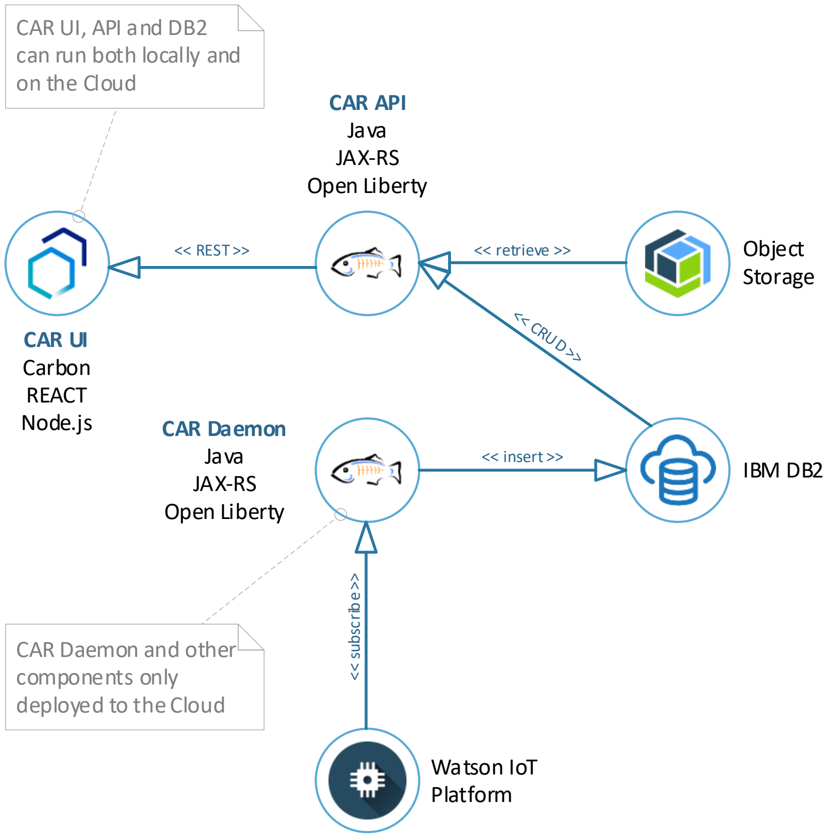
Carbon is a library that can work with frameworks like **REACT**, **VUE**, etc.

Node.js is the server on which **Javascript** can run

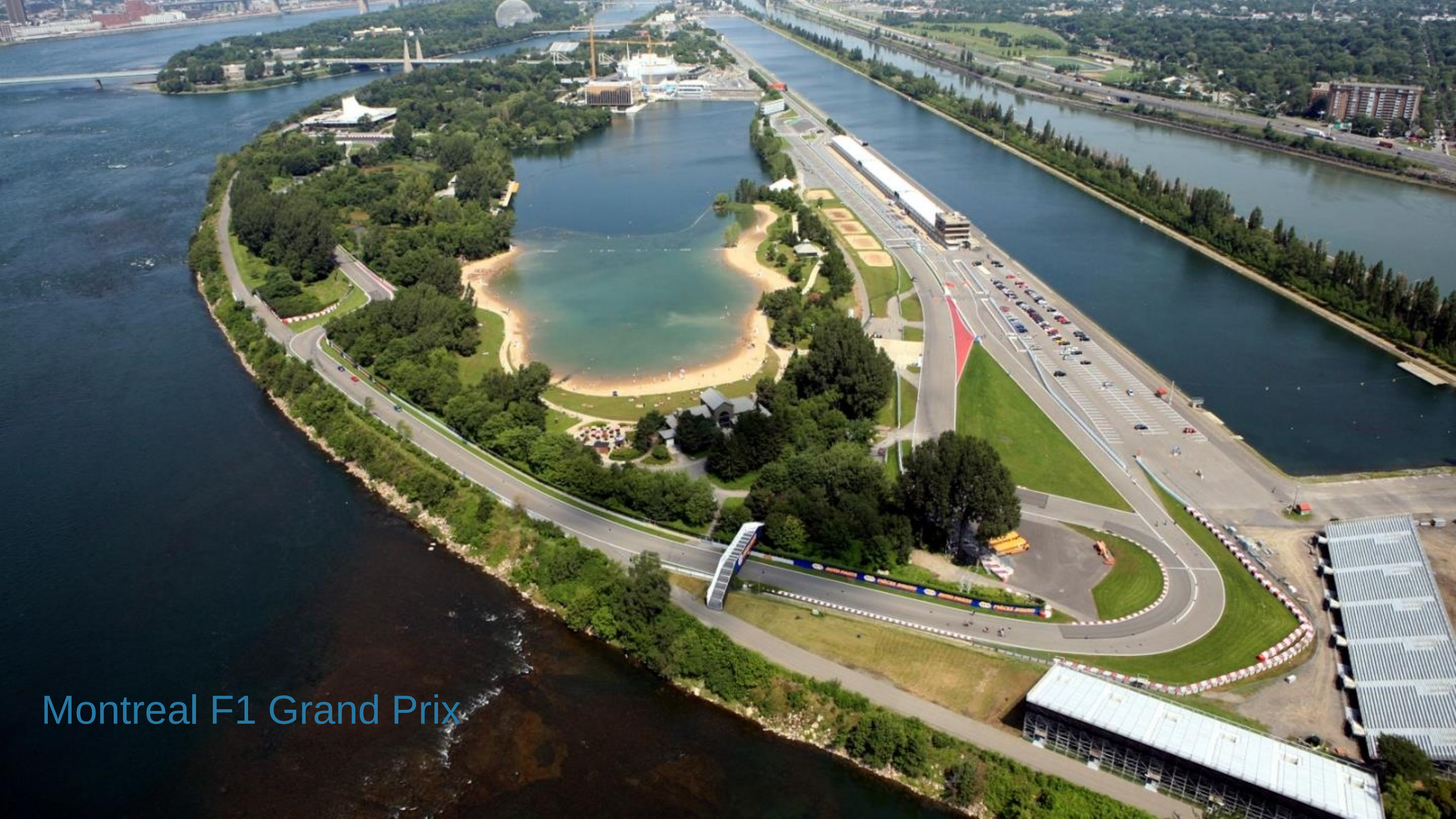
JAX-RS is a framework for working on **REST API** in Java

Open Liberty is a server to run the Java code on



CAR UI, API and DB2 can run both locally and on the Cloud

CAR Daemon and other components only deployed to the Cloud



Montreal F1 Grand Prix

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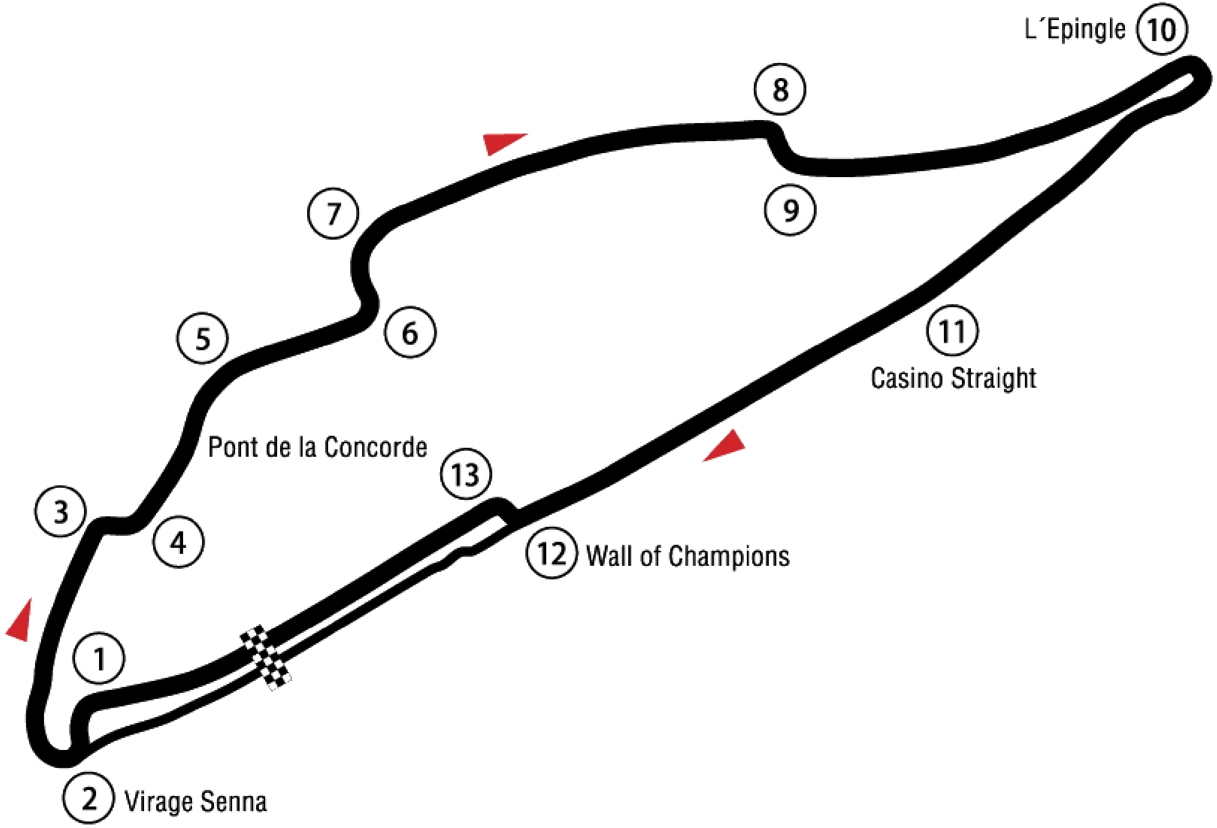
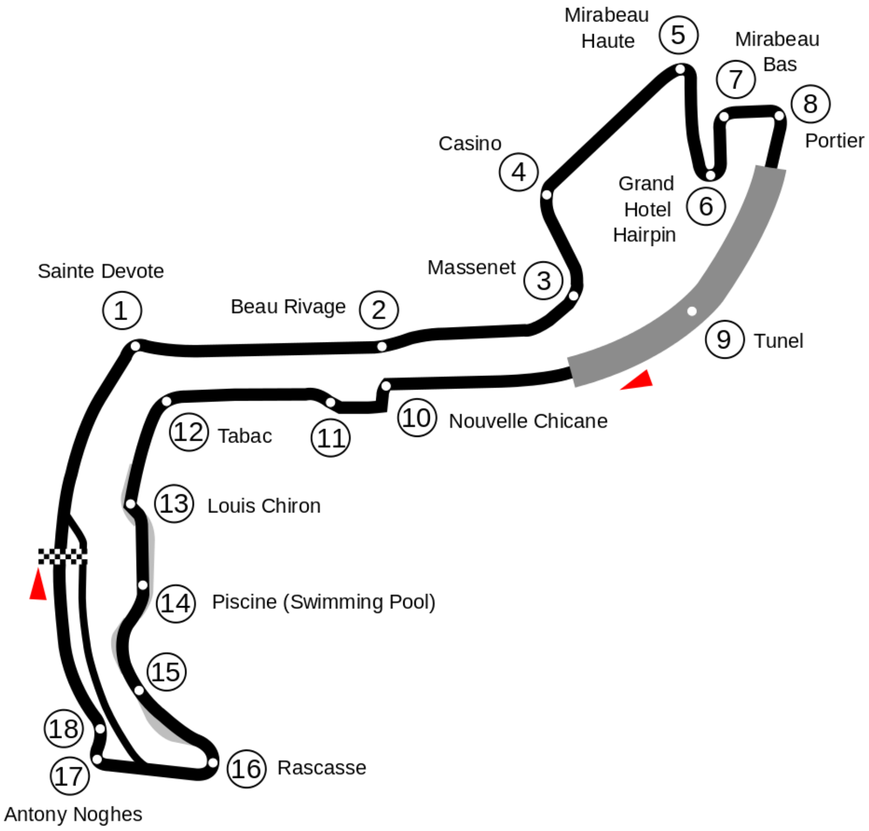
Montreal F1



Monte Carlo F1 Grand Prix

Cognitive Autonomous Racer

Monte Carlo F1



CAR Learning Resources

Tutorials and documents to guide students to learn the technology

Java JAX RS

Open Liberty™

An IBM Open Source Project

A lightweight open framework for building fast and efficient cloud-native Java microservices.

Build cloud-native apps and microservices while running only what you need. Open Liberty™ is the most flexible server runtime available to Java™ developers in this solar system.

Get **Eclipse IDE 2021-06**

Install your favorite desktop IDE packages.

ORACLE

Java / Technologies /
Java SE 16 - Downloads

Building RESTful Web Services with JAX-RS

https://docs.oracle.com/cd/E19798-01/821-1841/6nmq2cp1v/index.html

Open Liberty REST microservices

https://openliberty.io/docs/21.0.0.7/rest-microservices.html

Open Liberty REST Guides

https://openliberty.io/guides/#restful_service

Open Liberty REST Guides

https://openliberty.io/guides/#restful_service

Eclipse Download

https://www.eclipse.org/downloads/

Java Download

https://www.oracle.com/java/technologies/javase-jdk16-downloads.html

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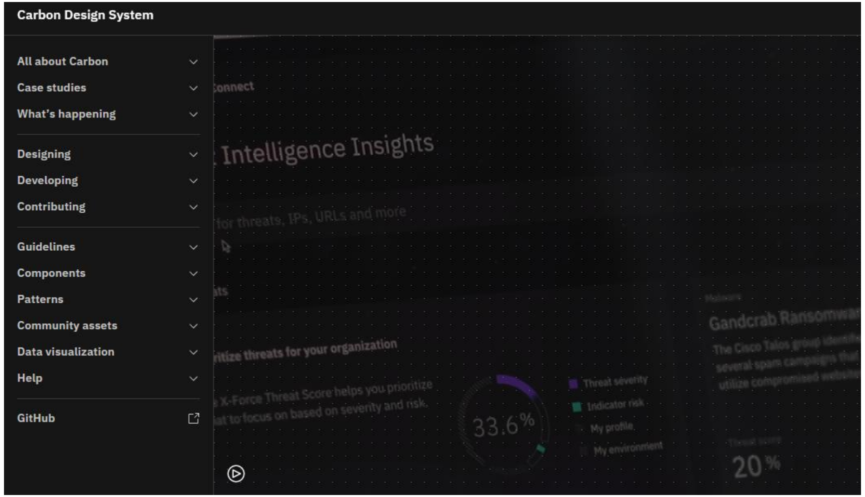
Carbon REACT

Carbon Design System

Carbon is IBM’s open source design system for products and digital experiences. With the IBM Design Language as its foundation, the system consists of working code, design tools and resources, human interface guidelines, and a vibrant community of contributors.



Carbon Design System REACT Tutorial

https://www.carbondesignsystem.com/developing/react-tutorial/overview/

REACT Tutorial

https://reactjs.org/tutorial/tutorial.html

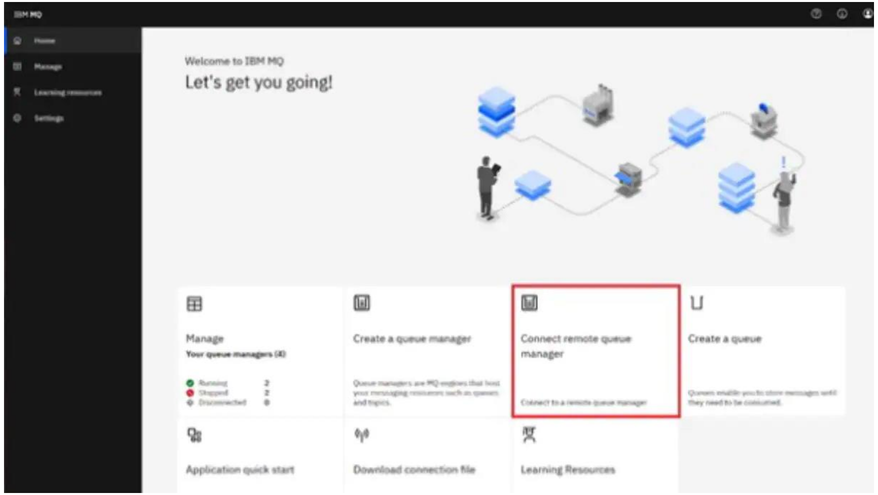
Eclipse Download for Git management

https://www.eclipse.org/downloads/

Visual Studio Code Download

https://code.visualstudio.com/download

IBM Asset [Asset name]



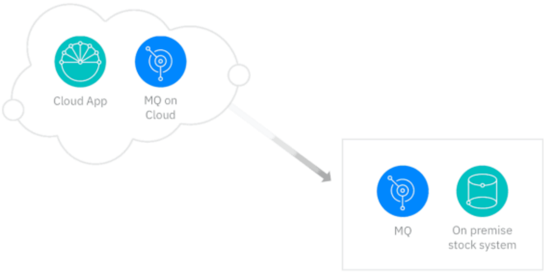
Welcome to IBM MQ

Let's get you going!

Queue managers are MQ engines that host your messaging resources such as queues and topics.

Connect to a remote queue manager

Queues enable you to store messages until they need to be consumed.



IBM MQ

https://www.ibm.com/products/mq

MQTT Server on MQ

https://www.ibm.com/docs/en/ibm-mq/8.0?topic=telemetry-send-message-mq-application-from-mqtt-client

IBM MQ Docker

https://hub.docker.com/r/ibmcom/mq/

IBM MQ Documentation

https://www.ibm.com/docs/en/ibm-mq/9.2

IBM MQ Java:

https://www.ibm.com/docs/en/ibm-mq/9.2?topic=java-mq-classes

https://www.ibm.com/docs/en/ibm-mq/9.2?topic=applications-operations-queue-managers

IBM MQ Downloads for developers

https://developer.ibm.com/articles/mq-downloads/

IBM DB2

https://www.ibm.com/products/db2-database

IBM DB2

https://www.ibm.com/products/db2-database

Introduction to Database Systems by C.J. Date

https://docs.google.com/file/d/0B9aJA_iV4kHYR1I1Q1MxQ2VzX0U/edit?resourcekey=0-m-SoWfxx0CbK6tjYrMttow

IBM DB2 Docker

https://hub.docker.com/r/ibmcom/db2

IBM DB2 Java:

https://github.com/IBM/db2-samples/tree/master/java/jdbc

IBM DB2 Documentation:

https://www.ibm.com/docs/en/db2/11.5

Structured Query Language (SQL):

https://www.ibm.com/docs/en/db2oc?topic=reference-sql

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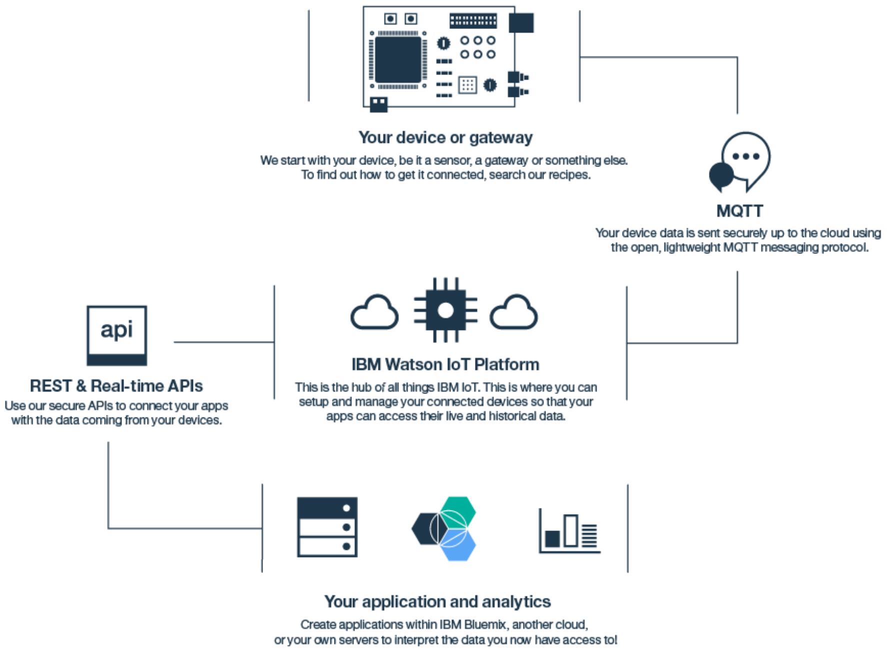


Your device or gateway

We start with your device, be it a sensor, a gateway or something else. To find out how to get it connected, search our recipes.

MQTT

Your device data is sent securely up to the cloud using the open, lightweight MQTT messaging protocol.

REST & Real-time APIs

Use our secure APIs to connect your apps with the data coming from your devices.

IBM Watson IoT Platform

This is the hub of all things IBM IoT. This is where you can setup and manage your connected devices so that your apps can access their live and historical data.

Your application and analytics

Create applications within IBM Bluemix, another cloud, or your own servers to interpret the data you now have access to!

paho

OASIS

MQTT Version 5.0

Watson IoT Platform documentation

https://cloud.ibm.com/docs/IoT

Watson IoT Platform tutorial

https://www.ibm.com/docs/en/watson-iot-platform?topic=started-quick-start-tutorial

Eclipse Paho Java library

https://www.eclipse.org/paho/index.php?page=clients/java/index.php

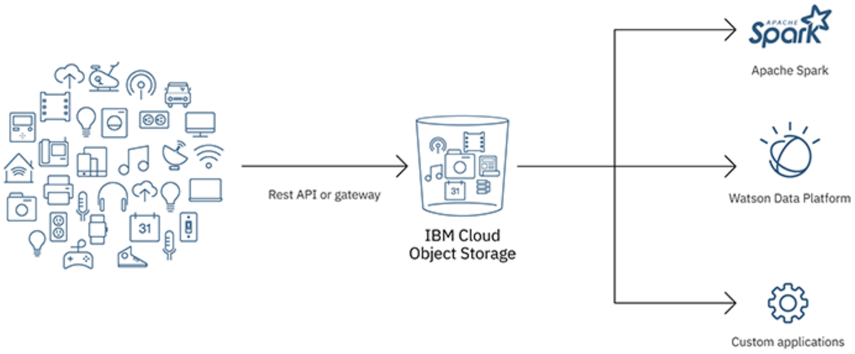
MQTT v 5.0 Specification

https://docs.oasis-open.org/mqtt/mqtt/v5.0/mqtt-v5.0.docx

Maven:

https://mvnrepository.com/artifact/org.eclipse.paho/org.eclipse.paho.mqttv5.client/1.2.5

Cognitive Autonomous Racer



Cloud Object Storage documentation

https://cloud.ibm.com/docs/cloud-object-storage

Cloud Object Storage API

https://cloud.ibm.com/apidocs/cos/cos-compatibility

https://cloud.ibm.com/docs/cloud-object-storage?topic=cloud-object-storage-compatibility-api

Cloud Object Storage Developer Guide

https://cloud.ibm.com/docs/cloud-object-storage?topic=cloud-object-storage-dev-guide

Python:

https://ibm.github.io/ibm-cos-sdk-python/reference/services/s3.html

Java:

https://ibm.github.io/ibm-cos-sdk-java/index.html

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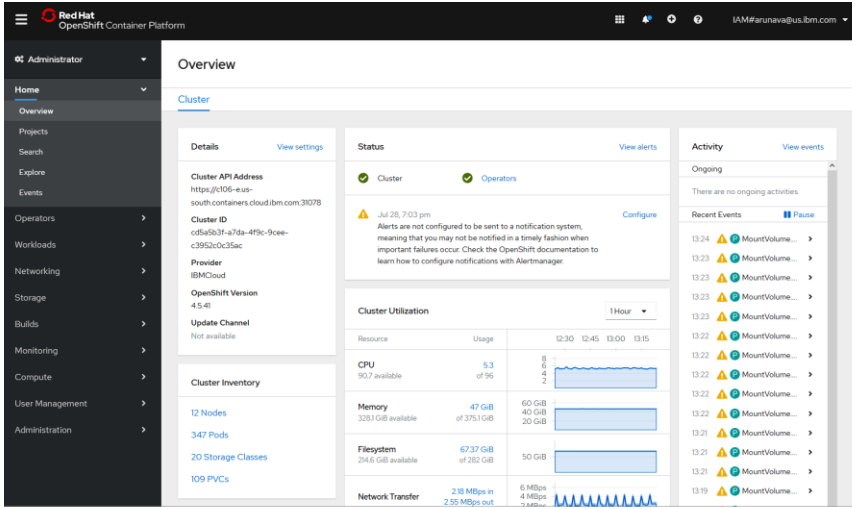


Details

Cluster API Address
https://c106-e.us-south.containers.cloud.ibm.com:31078

Cluster ID
cd5a5b3f-a7da-4f9c-9cee-c3952c0c35ac

Provider
IBMCloud

OpenShift Version
4.5.41

Update Channel
Not available

Cluster Inventory

12 Nodes
347 Pods
20 Storage Classes
109 PVCs

Status

Cluster
Operators

Jul 28, 7:03 pm
Alerts are not configured to be sent to a notification system, meaning that you may not be notified in a timely fashion when important failures occur. Check the OpenShift documentation to learn how to configure notifications with Alertmanager.

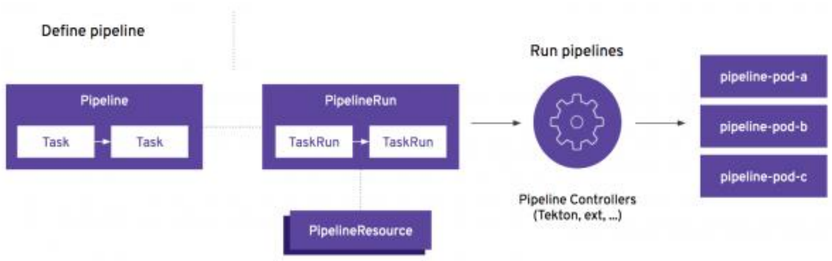
Cluster Utilization

Resource	Usage
CPU 90.7 available	5.3 of 96
Memory 328.1 GiB available	47 GiB of 375.1 GiB
Filesystem 214.6 GiB available	67.37 GiB of 282 GiB
Network Transfer	2.18 MBps in 2.55 MBps out

Activity

Ongoing
There are no ongoing activities.

Recent Events
13:24 MountVolume...
13:23 MountVolume...
13:23 MountVolume...
13:23 MountVolume...
13:23 MountVolume...
13:22 MountVolume...
13:22 MountVolume...
13:22 MountVolume...
13:22 MountVolume...
13:22 MountVolume...
13:21 MountVolume...
13:21 MountVolume...
13:21 MountVolume...
13:19 MountVolume...



Introduction to Terraform

https://www.terraform.io/intro/index.html

Creating Modules in Terraform

https://www.terraform.io/docs/language/modules/develop/index.html

Terraform IBM Cloud Provider

https://registry.terraform.io/providers/IBM-Cloud/ibm/latest/docs

OpenShift Pipelines Tutorial using Tekton

https://github.com/openshift/pipelines-tutorial

Introducing OpenShift Pipelines

https://cloud.redhat.com/blog/introducing-openshift-pipelines

Creating Tekton Pipelines

https://developers.redhat.com/blog/2020/04/30/creating-pipelines-with-openshift-4-4s-new-pipeline-builder-and-tekton-pipelines#

CAR Messaging and Data Pipeline

Communication with MQ and the IoT network for transferring data and training models

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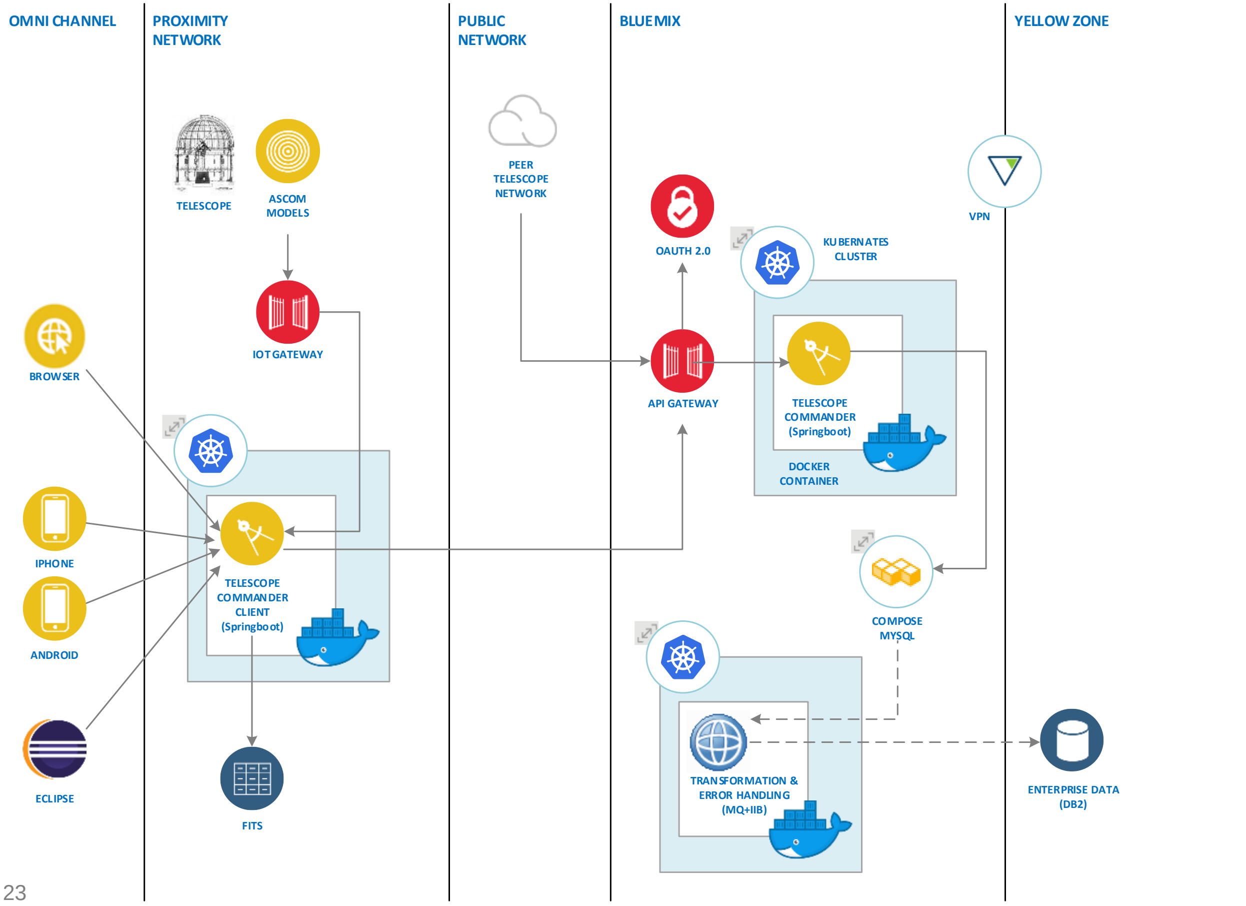
Reference Architecture



- IoT Architecture
  - Based on the Reference Architecture for CTN

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https://towardsdatascience.com/why-tesla-wont-use-lidar-57c325ae2ed5

https://mushr.io/tutorials/quickstart/

https://developer.nvidia.com/blog/training-your-jetbot-in-isaac-sim/

https://f1tenth.org/learn.html

https://aws.amazon.com/deepracer/

https://www.donkeycar.com/

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https://magpi.raspberrypi.com/articles/make-a-3d-camera

https://store.opencv.ai/products/oak-d

https://www.intelrealsense.com/depth-camera-d455/

Learning Occluded Shapes for 3D Object Detection

https://arxiv.org/pdf/2112.02205v1.pdf

Stereo Visual Odometry

https://avisingh599.github.io/vision/visual-odometry-full/

https://github.com/avisingh599/vo-howard08

https://www.cs.cmu.edu/~kaess/vslam_cvpr14/media/VSLAM-Tutorial-CVPR14-A12-StereoVO.pdf

Visual Simultaneous Localization and Mapping (vSLAM)

https://ipsjcva.springeropen.com/articles/10.1186/s41074-017-0027-2

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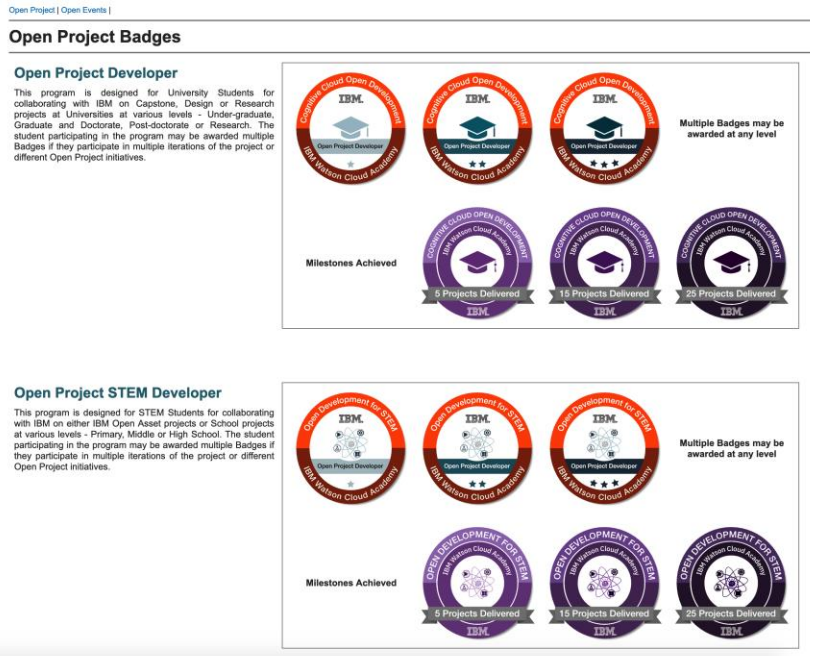
CAR Project Iterations

Study the work done by the previous teams to build on to the project

IBM Watson Open Badges Roadmap



Open Project | Open Events |

Open Project Badges

Open Project Developer

This program is designed for University Students for collaborating with IBM on Capstone, Design or Research projects at Universities at various levels - Under-graduate, Graduate and Doctorate, Post-doctorate or Research. The student participating in the program may be awarded multiple Badges if they participate in multiple iterations of the project or different Open Project initiatives.

Multiple Badges may be awarded at any level

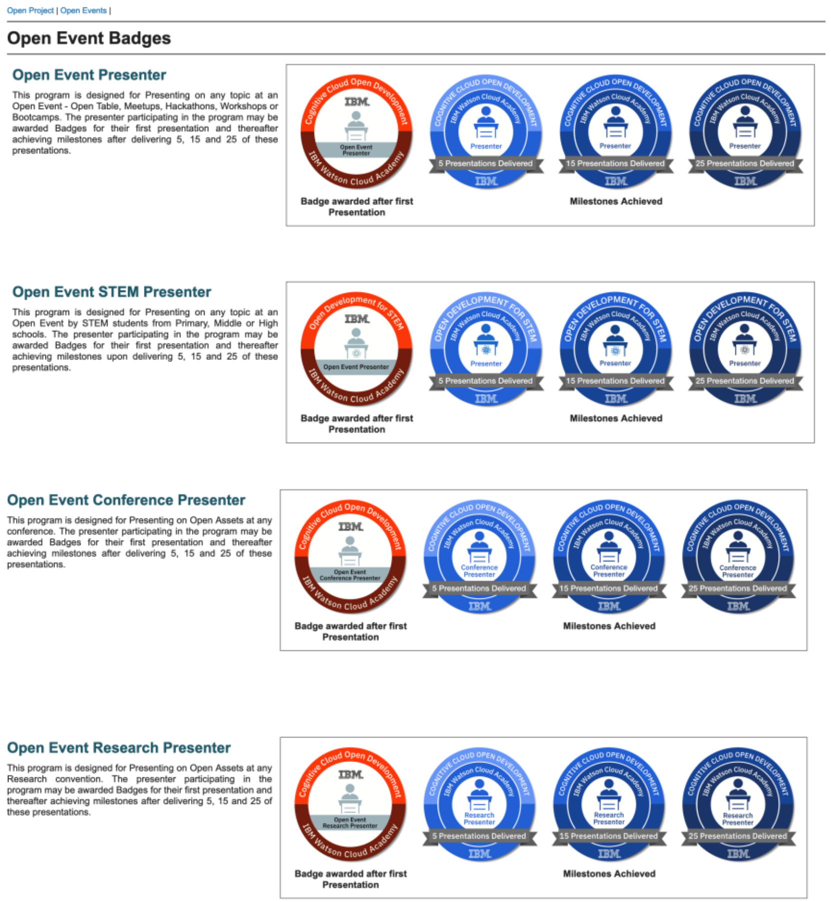
Milestones Achieved

Open Project STEM Developer

This program is designed for STEM Students for collaborating with IBM on either IBM Open Asset projects or School projects at various levels - Primary, Middle or High School. The student participating in the program may be awarded multiple Badges if they participate in multiple iterations of the project or different Open Project initiatives.

Multiple Badges may be awarded at any level

Milestones Achieved



Open Project | Open Events |

Open Event Badges

Open Event Presenter

This program is designed for Presenting on any topic at an Open Event - Open Table, Meetups, Hackathons, Workshops or Bootcamps. The presenter participating in the program may be awarded Badges for their first presentation and thereafter achieving milestones after delivering 5, 15 and 25 of these presentations.

Badge awarded after first Presentation

Milestones Achieved

Open Event STEM Presenter

This program is designed for Presenting on any topic at an Open Event by STEM students from Primary, Middle or High schools. The presenter participating in the program may be awarded Badges for their first presentation and thereafter achieving milestones upon delivering 5, 15 and 25 of these presentations.

Badge awarded after first Presentation

Milestones Achieved

Open Event Conference Presenter

This program is designed for Presenting on Open Assets at any conference. The presenter participating in the program may be awarded Badges for their first presentation and thereafter achieving milestones after delivering 5, 15 and 25 of these presentations.

Badge awarded after first Presentation

Milestones Achieved

Open Event Research Presenter

This program is designed for Presenting on Open Assets at any Research convention. The presenter participating in the program may be awarded Badges for their first presentation and thereafter achieving milestones after delivering 5, 15 and 25 of these presentations.

Badge awarded after first Presentation

Milestones Achieved

Open Event Presenter
Presenter
Conference Presenter
Research Presenter
5 Presentations Delivered
15 Presentations Delivered
25 Presentations Delivered

Thank
You
Vinaka
köszönöm
Kiitos
Maake
Asante
Shukria
Dhanyavadagalu
감사합니다
Dankscheen
спасибо
Kam Sah Hammida
شكرا
Manana
Dankon
Matondo
Dank Je
Mauruuru
Biyan
Diolch i Chi
Terima Kasih
Taiku
Tack
Blagodaram
Ngiyabonga
Dziekuje
Chokrane
Grazie
Juspaxar
Arigato
Mochchakkeram
Gracias
நன்றி
Bedankt
D'akujem
धन्यवाद
cảm ơn bạn
Kop Khun Khap
Paldies
Tingki
Ua Tsaug Rau Koj
Grazas
Di Ou Mèsi
Kia Ora
Gratias Tibi
Obrigado
Děkuji
Matur Nuwun
Nirringrazzjak
ありがとう
Suksama
Rahmat
谢谢
хвала
Hvala
Welalin
Djiere Dieuf
Misaotra
Danke
Merci
Salamat
Go Raibh Maith Agat
Tuke
Eskerrik Asko
ขอขอบคุณคุณ
Najis