3rd Buffalo Day for 5G and Wireless Internet of Things

CloudRAFT: A Cloud-based Framework for Remote Experimentation for Mobile Networks

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Motivation

Existing community experimentation platforms
- Focus on specific areas in wireless research
- Deployed in pre-selected environments with nodes installed at fixed locations
- Challenging to test the generalizability of the obtained results

Needs a systematic shift in the paradigm of sharing experimentation facilities for wireless research

Proposed Solution

A cloud-based framework called CloudRAFT, that allows experimenters to
- Remotely access and control experimental resources via public cloud AWS and
- Share the resulting data and code via the cloud

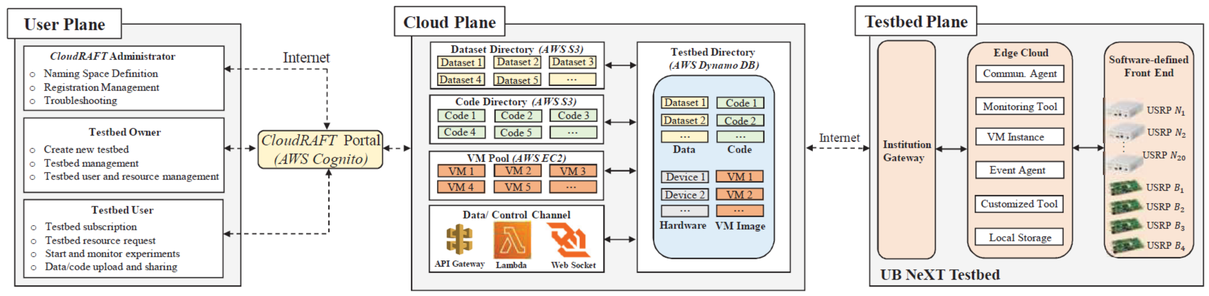
Three Plane Architecture

❑ User Plane
- Manage three types of users, i.e., the *CloudRAFT Administrator*, the *Testbed Owner*, and *Testbed User*
- *CloudRAFT administrator*
  - ❖ Oversee the operation of CloudRAFT
- *Testbed owners*
  - ❖ Create, Manage and Configure new testbed profiles
- *Testbed User*
  - ❖Subscribe and Reserve testbeds
  - ❖Conduct and monitor status of experiments
  - ❖Share the collected datasets via CloudRAFT

❑ Cloud Plane
- Provides software and tools that can be used for testbed owners to conveniently share their testbeds with the community
- Hides the complexity in accessing different testbeds
- Provides a bridge between researchers and testbed developers
- Accelerates the formation of a mature ecosystem for experimental research for the wireless community

❑ Testbed Plane
- Provides a set of three tools in addition to the custom tools made available by the testbed owners
- *Communication Agent* - Relay between the Cloud Plane and the edge cloud
- *Event Agent - Receives and executes control*
- *commands*
- *Monitoring Tool -feeds the real-time status of various computing and SDR devices*

CloudRAFT Architecture



CloudRAFT Enabling Techniques

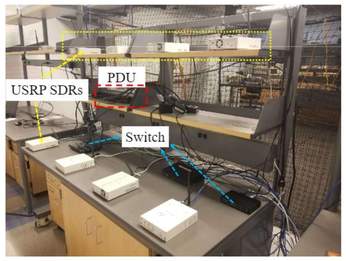
❑ Amazon Serverless Service
- Takes care of infrastructure management tasks allowing testbed and CloudRAFT developers to focus on the program development
- Offers a wide array of APIs including Representational State Transfer (REST) API Gateway, Websocket API Gateway, Lambda Function, DynamoDB, Simple Storage Service (S3), and Cognito, among others

❑ Websocket Based Real Time Communication
- Takes care of the communications between the CloudRAFT control plane and the testbed edge server

❑ Fast Reverse Proxy
- Redirects the Internet requests from one IP address to another using TCP or UDP connections
- Hides the testbed IP address and preserve the integrity of the testbed information

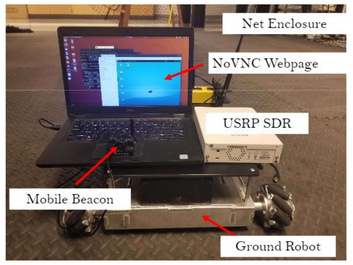
❑ VNC-Based Remote Command Line
- Allows desktop sharing and enables remote execution of commands from a unified webportal

UBNext Testbed Design



Front-end SDR
20 N210 and 4 B210USRPs

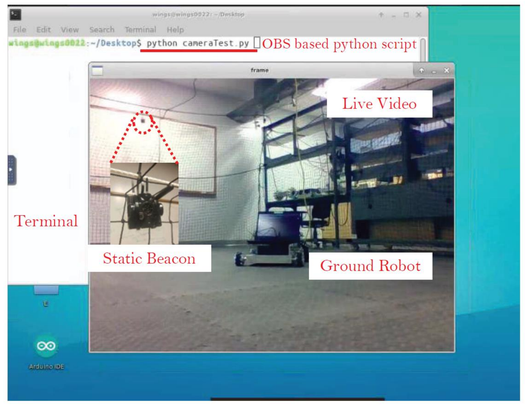
Edge server
Dell EMC R340PowerEdge workstations



Ground Robot
SuperDroid programmable robot
Marvelmind super beacon

Live Video Streaming

- Stream the live video of the experiment based on a combination of Open Broadcaster Software (OBS) and Real-Time Messaging Protocol (RTMP).



Conclusions

- We presented CloudRAFT, a cloud based remote experimentation framework for mobile networks
- We discussed the enabling techniques for CloudRAFT.
- We also developed a new software-defined testbed called UBNeXT and showcased the remote access to NeXT based on CloudRAFT.

Future Work

- Standardize the communication interfaces between the cloud plane and testbed plane within the CloudRAFT framework.
- Fully integrate the UBNeXT testbed by connecting other software radios available at University at Buffalo, including mmWave radios and UAV systems, among others.

References

1. S. K. Moorthy, C. Lu, Z. Guan, N. Mastronarde, G. Sklivanitis, D. Pados, E.S. Bentley, and M. Medley, "CloudRAFT: A Cloud-based Framework for Remote Experimentation for Mobile Networks," submitted for conference publication, October 2021