Institute for the Wireless Internet of Things
at Northeastern University

Platforms for Advanced Wireless Research

A survey of Wireless Mid Scale Research Infrastructure for Research and Experimentation

Abhimanyu Gosain
Department of Electrical and Computer Engineering
Northeastern University
agosain@coe.neu.edu

Platforms for Advanced Wireless Research

Kick-Off April 2017

Industry Consortium
<$ + In-Kind>
$50M

<$>
$50M

Level-Setting: PAWR Approach

Attribute	Approach
Problem Definition	Enhanced efforts of ~400 university researchers who need mid-scale testing capabilities to ensure success
Early Industry Involvement	Multi-use research platforms with “pre-competitive” research topic areas selected bottom-up by university PIs, with industry input
Research Scope	Mid-sized areas within cities, experimental platforms, 10-20 antenna sites, backhaul, SDRs
Flexibility and Speed	1 - 2 platforms per year in years 1,2 and 3
Streamlined governance, deployment, and operation	One governance consortium focused on upfront research and policy; city/university teams propose how to streamline deployment and ops

Charter Members

https://advancedwireless.org/partners

Mapping System Elements to a Changing Landscape

• Programmable Wireless (RF, Baseband) Substrate	Functional Disaggregation
• Wireless and/or Transport X-Haul	Move Processing closer to the edge
• Software configurable edge infrastructure	Softwarization + commodity hardware
• Modular Hardware; extensible; BYOD	Future Proof, Reduce CAPEX-OPEX
• White-Box and Black-Box User Equipment	DevOps + Closed Loop Network Automation

INITIAL BLUESKY TOPIC AREAS TO BE ENABLED BY RESEARCH PLATFORMS

mmWave/THz to enable R&D and systems testing at the millimeter-wave bands that are about 28GHz, 60GHz with a target of 100 Gbps in data rates for small-cell networks that cover a few city blocks.

Network Slicing to focus on the providing differential isolated Micro services to multiple users from RAN to Network slicing .

MANO provide support for ETSI and other MANO implementations to orchestrate end-to-end VM,container, VNF deployment in a cloud native environment including radio resources that operate on the wireless edge.

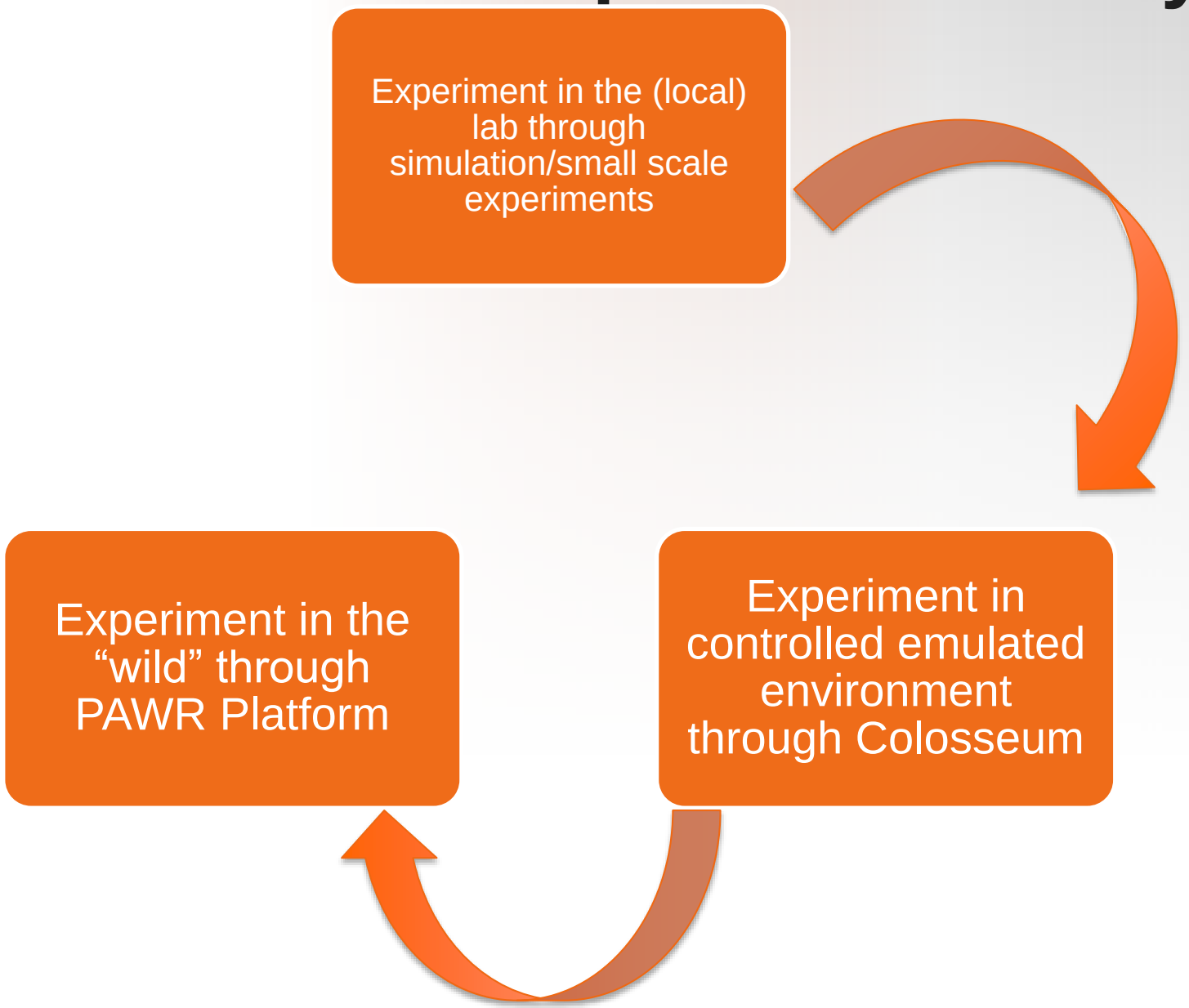
Microservices Architecture assembling, controlling, and composing services. We provide a service control plane that is layered on top of a diverse collection of back-end service implementations, including VM-hosted VNFs, container-based micro-services, and SDN-based control programs that embed functionality in white-box switches

Massive MIMO 2.5-2.7GHz and 3.5-3.7GHz 128 antenna element fully programmable radio to allow PHY/MAC/network FDD, full duplex research to design, build and demonstrate high bandwidth connectivity to multiple users simulataneously.

RAN CU-DU Split to advance capabilities of baseband-RRH and other functional splits being debated n different communities e.g.eCPRI, OTN backhaul, O-RAN.

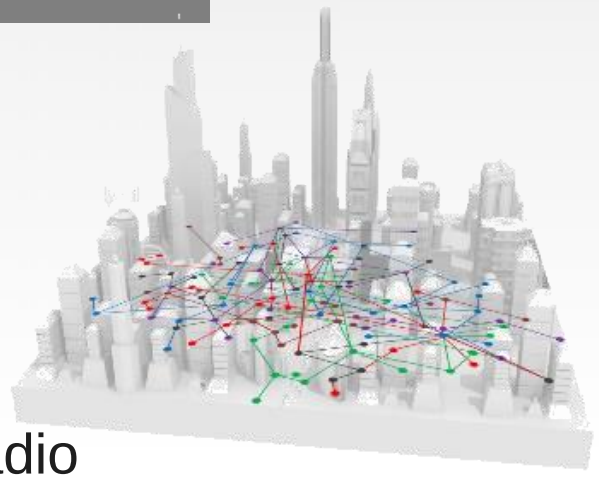
Applications/Services in later years – Platforms will serve as examples of Smart and Connected Community networks that demonstrate potential applications/services including Cyber-Physical Systems, Cyber-Security, Internet of Things, Robotics, Smart and Connected Health, and Big Data.

Envisioned Experiment LifeCycle



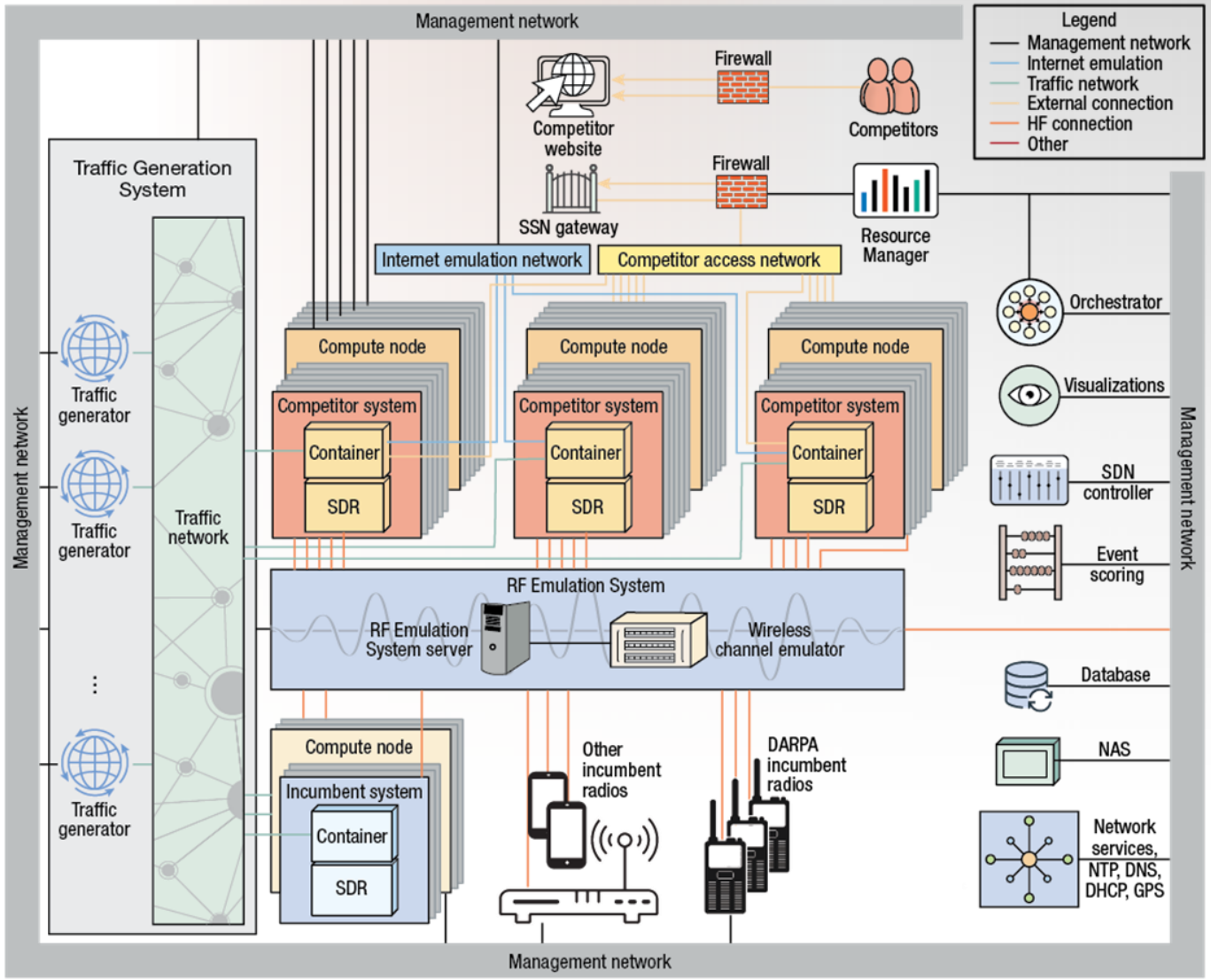
What is Colosseum?

Colosseum is the **world's largest** wireless network emulator with granularity at the RF signal level

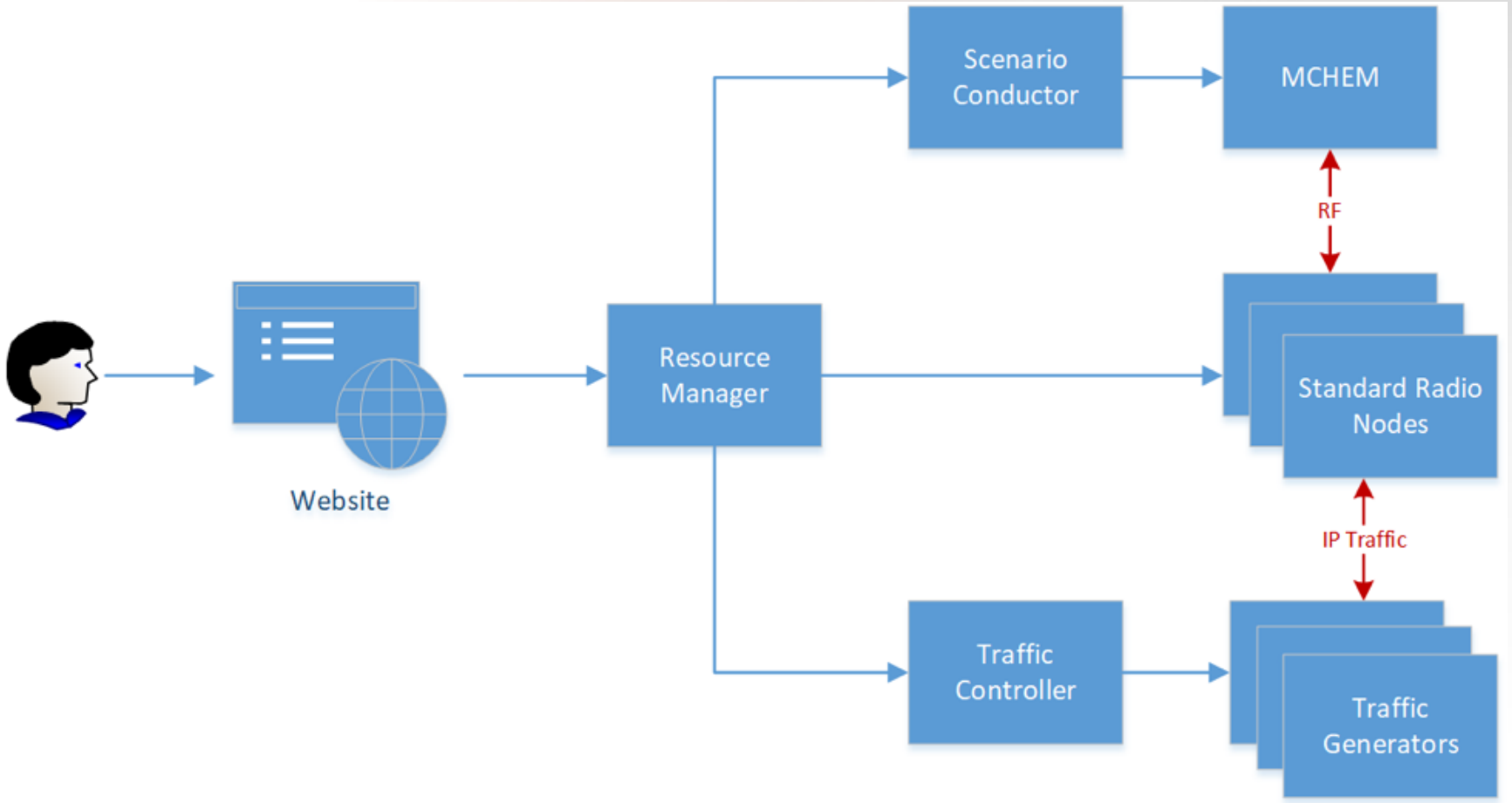


- 256 x 256 100 MHz RF channel emulation
- 128 Programmable Radio Nodes
- Computing resources (CPU, GPU, FPGA)
- Access control and scheduling infrastructure
- Supports remote shared access
- Colosseum is a General Purpose Cooperative Radio Development and Testing Environment
- https://www.darpa.mil/program/spectrum-collaboration-challenge

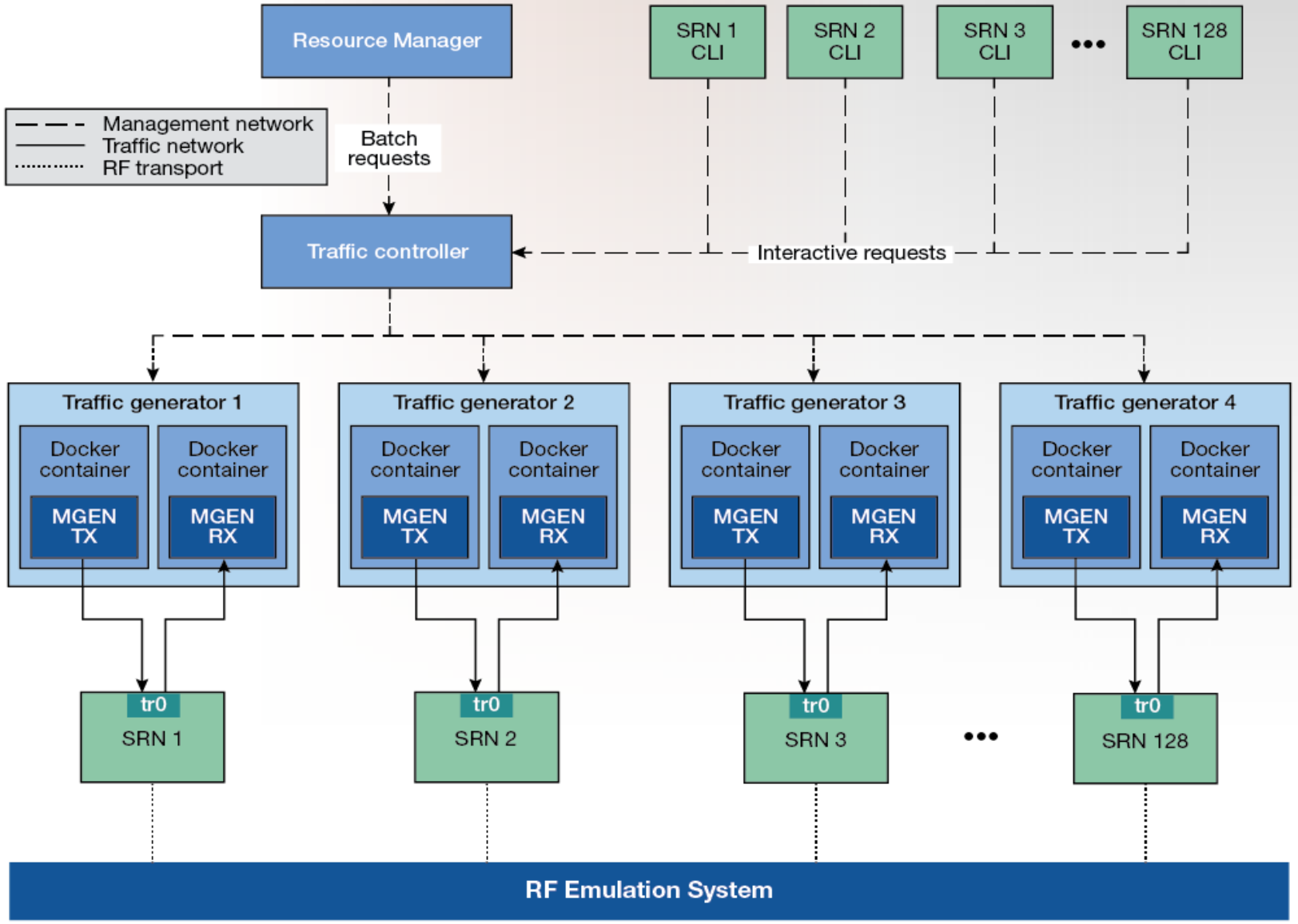
Colosseum Architecture



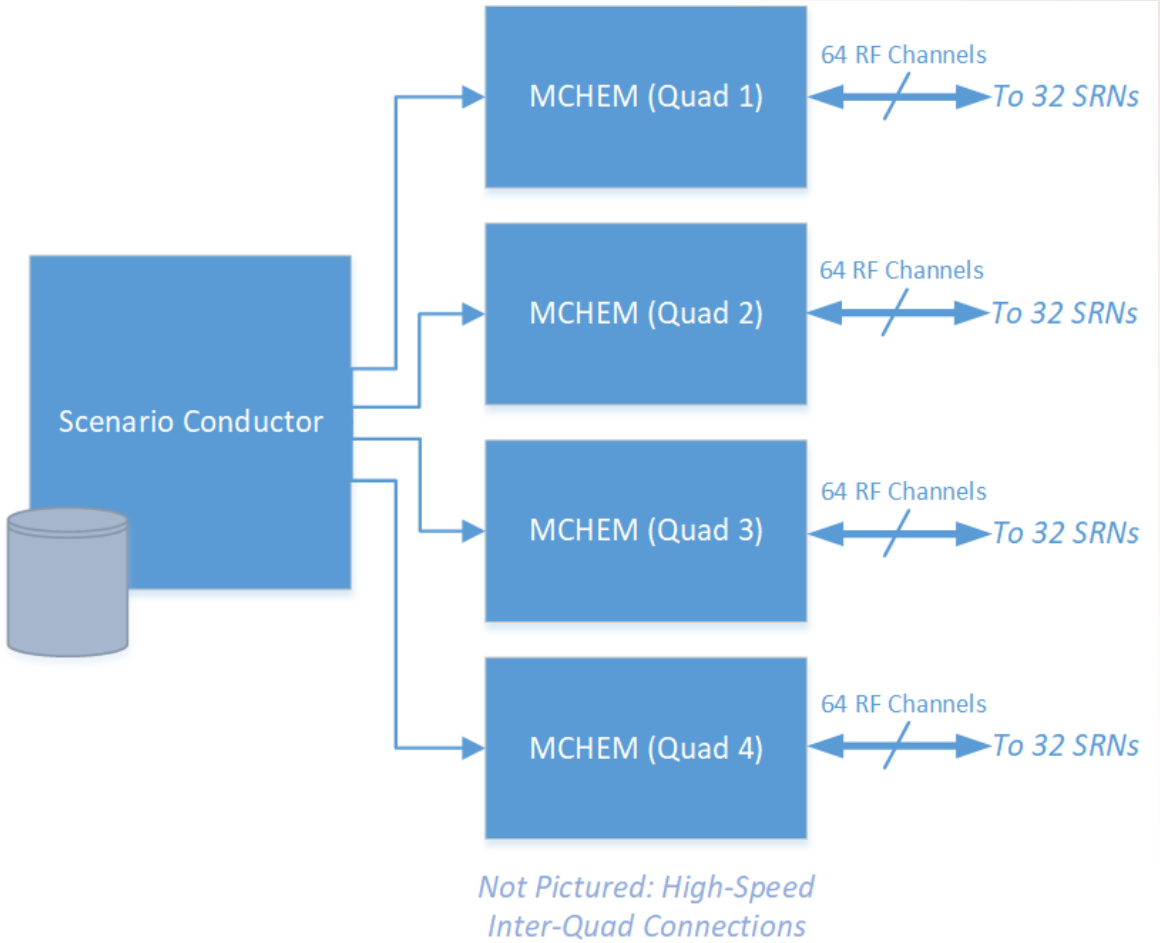
Components

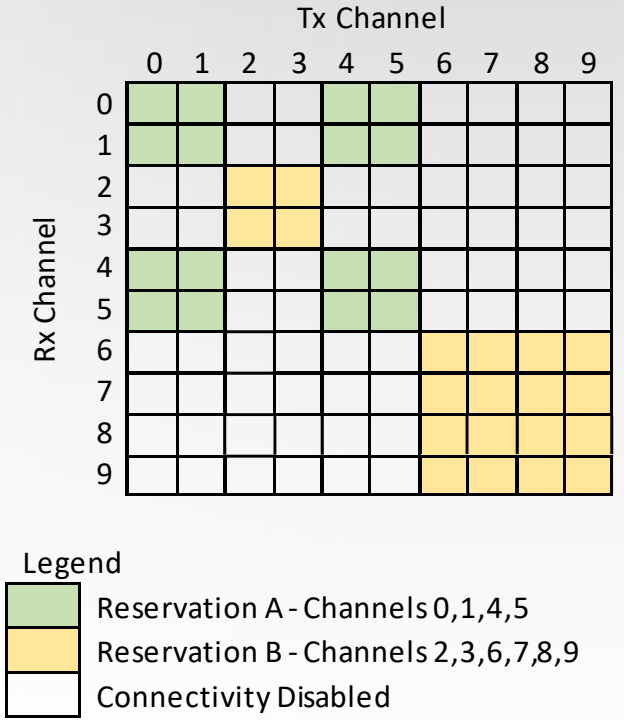

Scenario Conductor
MCHEM
RF
Website
Resource Manager
Standard Radio Nodes
IP Traffic
Traffic Controller
Traffic Generators

Traffic System



Scenario Conductor





PAWR Awardees

Announced April 9 2018

Round I Platforms

Salt Lake City

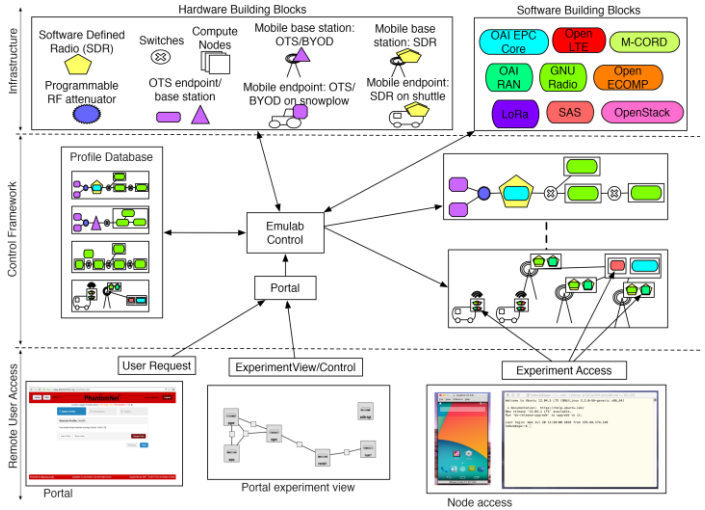
New York City

http://powderwireless.net

http://cosmos-lab.org

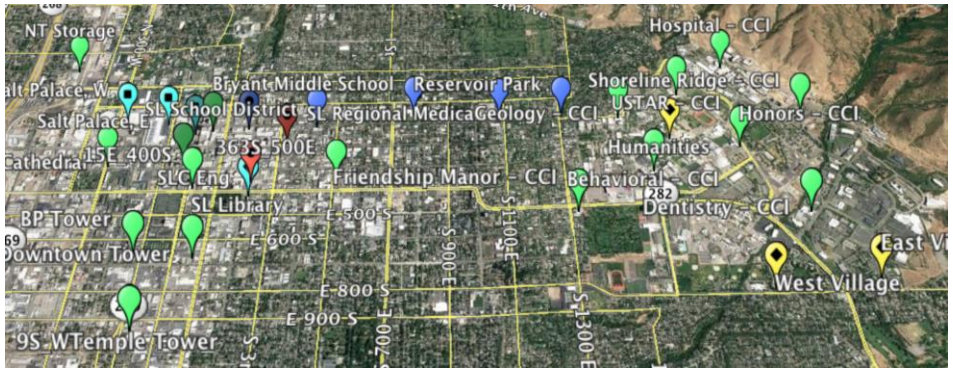
POWDER: Platform for Open Wireless Data-driven Experimental Research

- Next Generation Wireless Architecture
- Dynamic Spectrum Sharing
- Distinct environments: a dense urban downtown and a hilly campus environment.



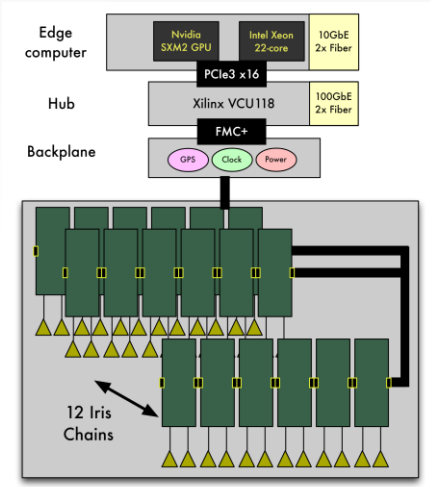
Control Framework with Hardware + Software Building Blocks

Deployment Area: UofU Campus +Downtown SLC + Connected Corridor



RENEW: A Reconfigurable Eco-system for Next-generation End-to-end Wireless

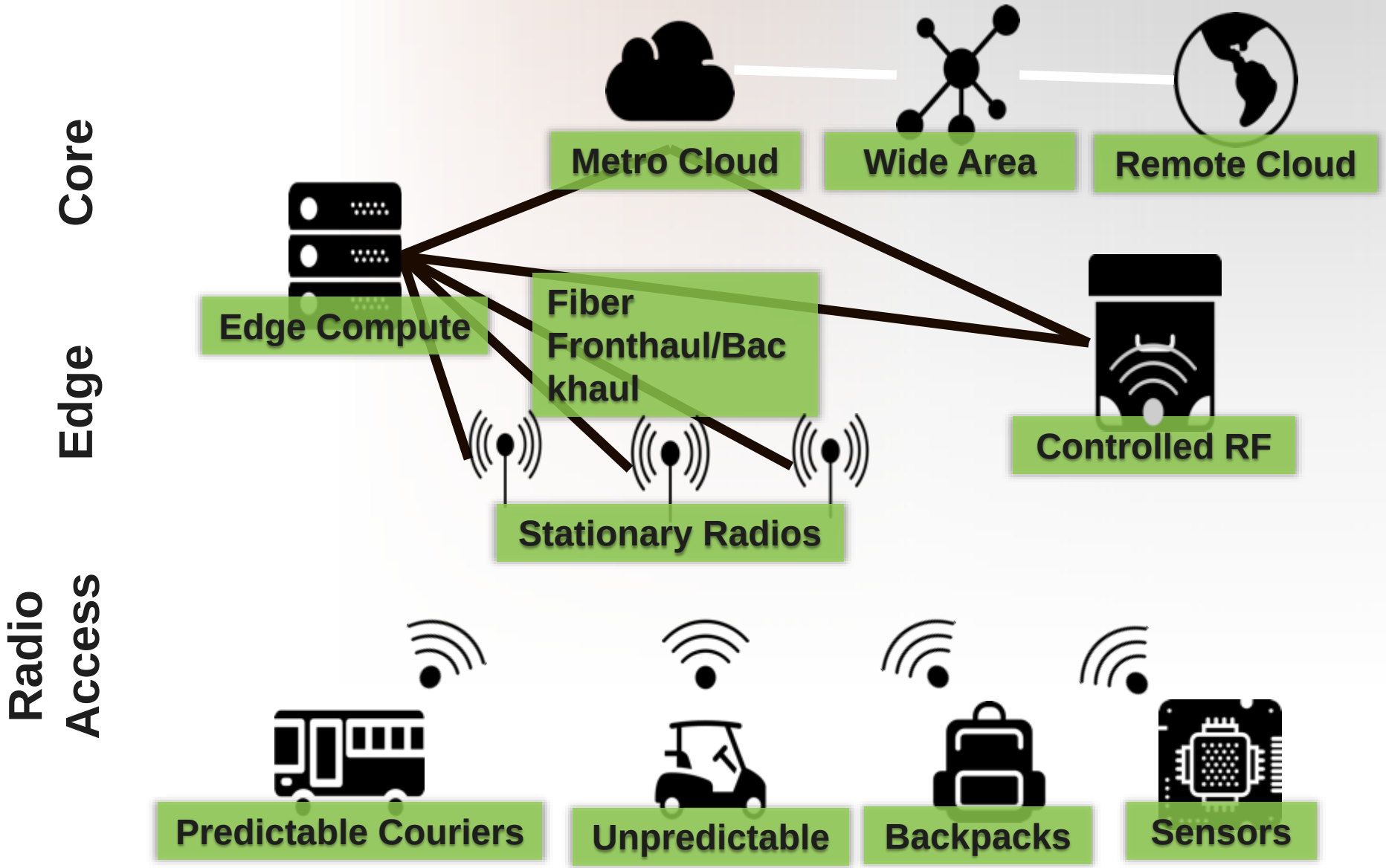
- RENEW Massive MIMO base station
- End-to-End Programmable
- Diverse Spectrum Access 50 MHz-3.8GHz
- Hybrid Edge computer composed of FPGA and GPU/CPU-based processing,
- Hub Board aggregates/distributes streams of radio samples



Architectural view of RENEW base station

IRIS software-defined radio modules

System Architecture



PAWR Round II Awardee

Announced Sept 18 2019

http://aerpaw.org

EMPOWER-PAWR Research Activity

1. ICT-20-2019-2020: 5G Long Term Evolution
2. Collaboration PAWR Projects & ICT-17 5G End to End platforms
    1. PAWR
        1. POWDER: Platform for Open Wireless Data-driven Experimental Research, in partnership with RENEW: Reconfigurable Ecosystem for Next-gen End-to-end Wireless (https://advancedwireless.org/salt-lake-city/)
        2. COSMOS: Cloud Enhanced Open Software Defined Mobile Wireless Testbed for City-Scale Deployment (https://advancedwireless.org/new-york-city/)
    2. H2020 ICT-17
        1. 5G-EVE European 5G validation platform for extensive trials (https://www.5G-eve.eu)
        2. 5G-VINNI 5G Verticals Innovation Infrastructure (https://5g-vinni.eu)
        3. 5Genesis, 5th Generation End-to-end Network, Experimentation, System Integration, and Showcasing (https://5genesis.eu)

Source:Kick-off meeting - EMpowering transatlantic PlatfOrms for advanced WirEless Research (824994)

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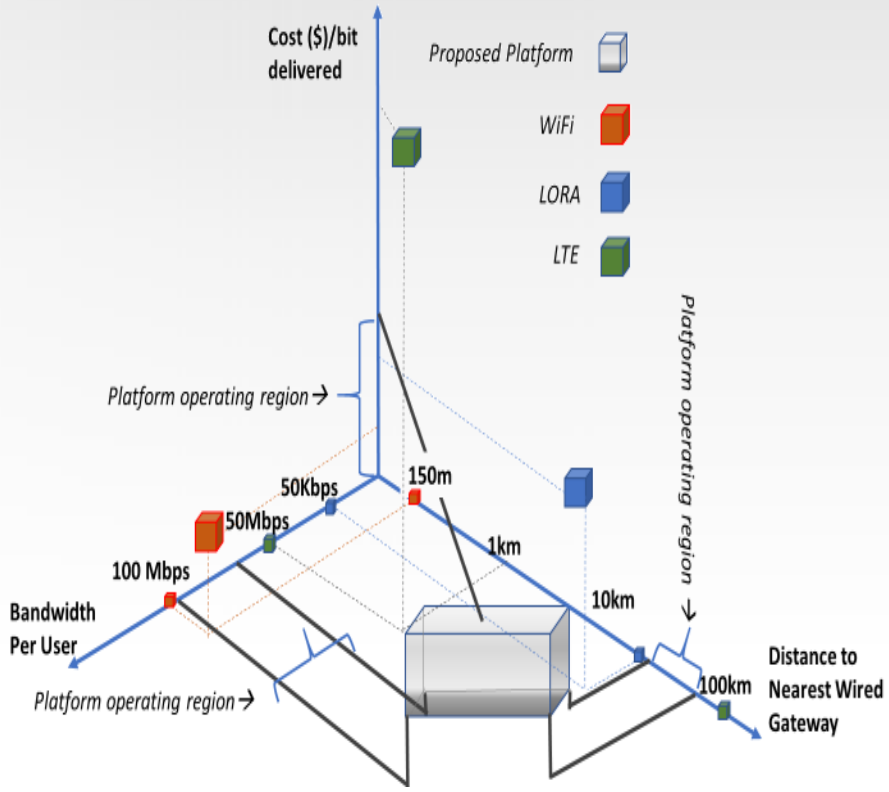
What Next ?

Round III RFP – Rural Broadband Focus

- ***Rural Focus:*** This third-round RFP seeks to focus on applying advanced wireless technologies to transform the deployment and operations of fast, low-latency, and reliable broadband networks in **rural and other low-density geographic areas** in an efficient and affordable way
- ***Innovative Technology****:* Proposers should create a testbed for experimenting with advanced wireless technologies and network architectures – combined with existing technologies – that may transform the existing rural broadband deployment cost curve through innovations in technologies and engineering processes



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http://advancedwireless.org

PAWR Project

http://powderwireless.net

http://renew.rice.edu

POWDER-RENEW

http://cosmos-lab.org

COSMOS

http://aerpaw.org

AERPAW