

ARA Wireless Living Lab for Smart and Connected Rural Communities



arawireless.org

Sarath Babu

AraFest '25, Tutorial, September 27—28, 2025

ARA

Tutorial Objectives

September 27th, 2025, 1:30PM - 4:10PM

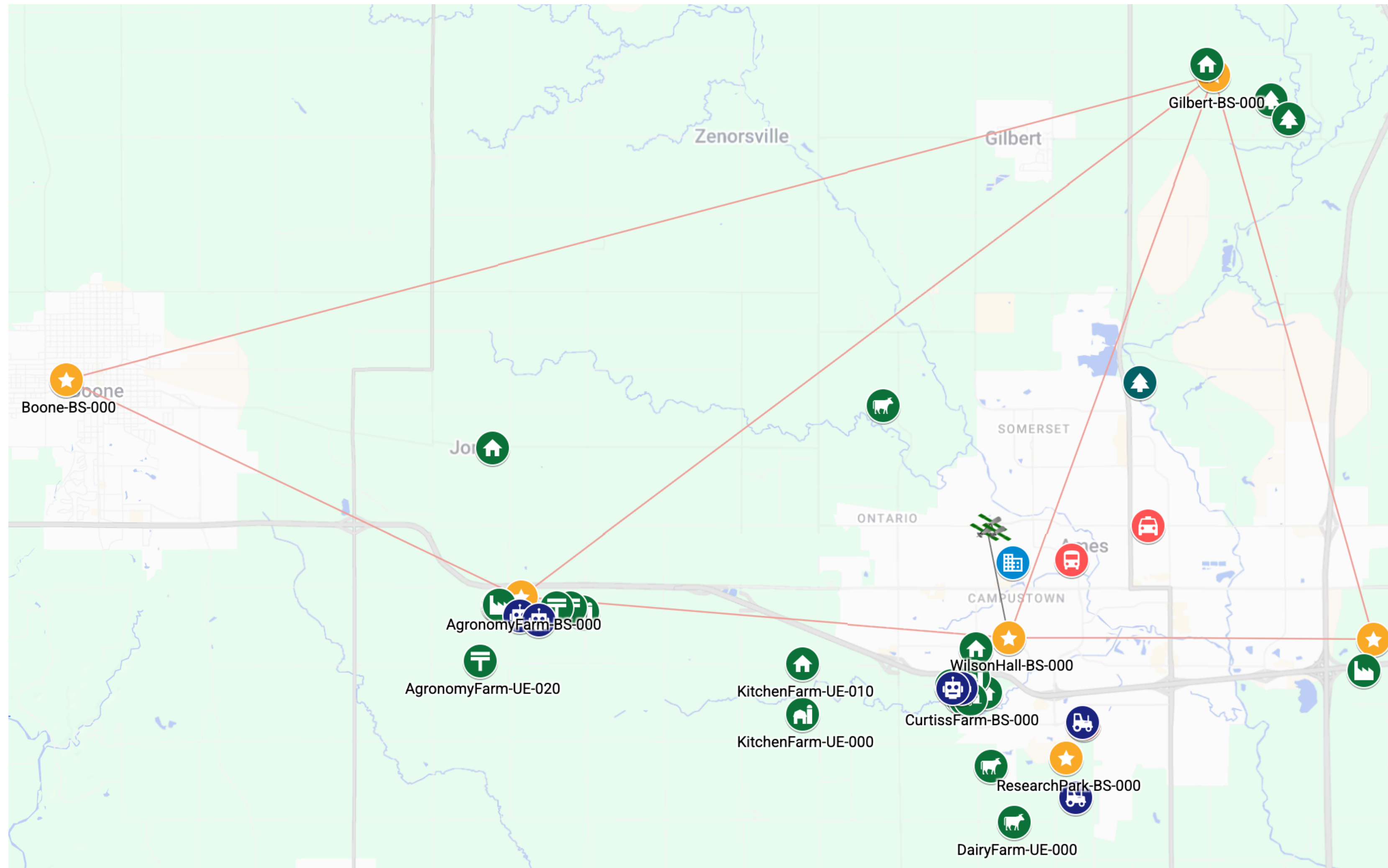
Overview of ARA: 1:30PM - 2:10PM

- ARA Software Overview
- ARA Experiment workflow
- Walk through ARA user manual (arawireless.readthedocs.io)
- Experiment automation
- Contributing to ARA

Hands-on Experimentation Session I — 2:10PM - 4:10PM

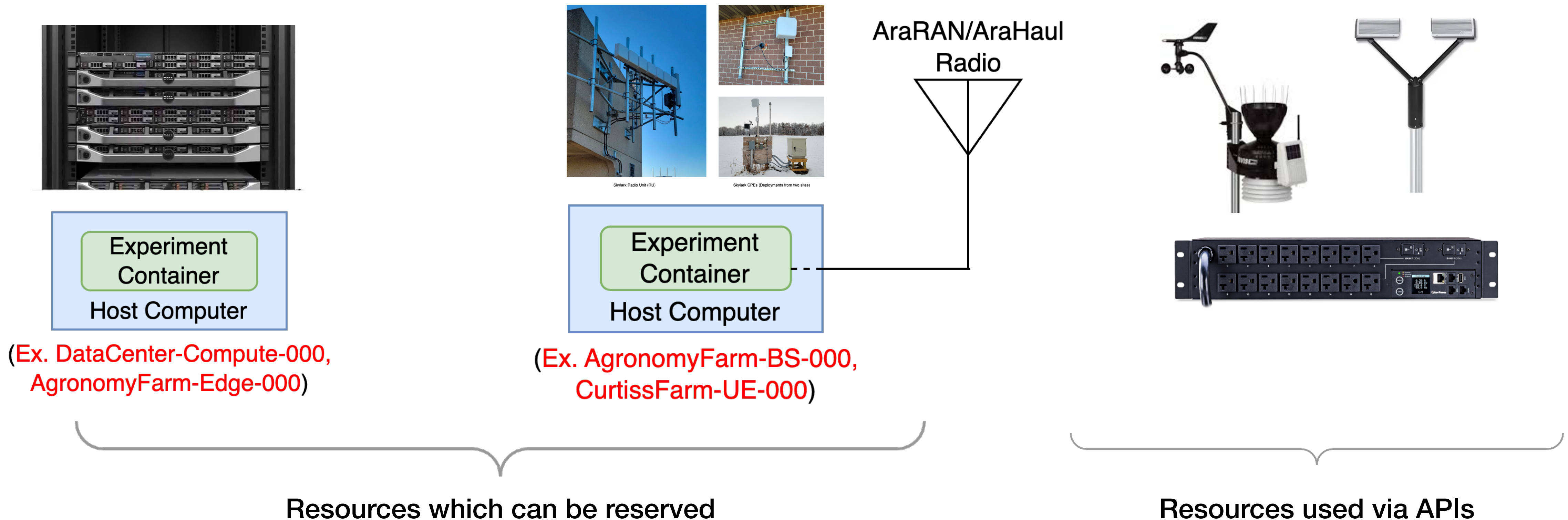
- Next Generation 5G Stacks (OAI & srsRAN) [4 Groups]
- MIMO [2 Groups]
- AraHaul [2 Groups]
- COTS [1 Group]
- ARA Generic Experimentation [1 Group]

ARA • Spatial Overview

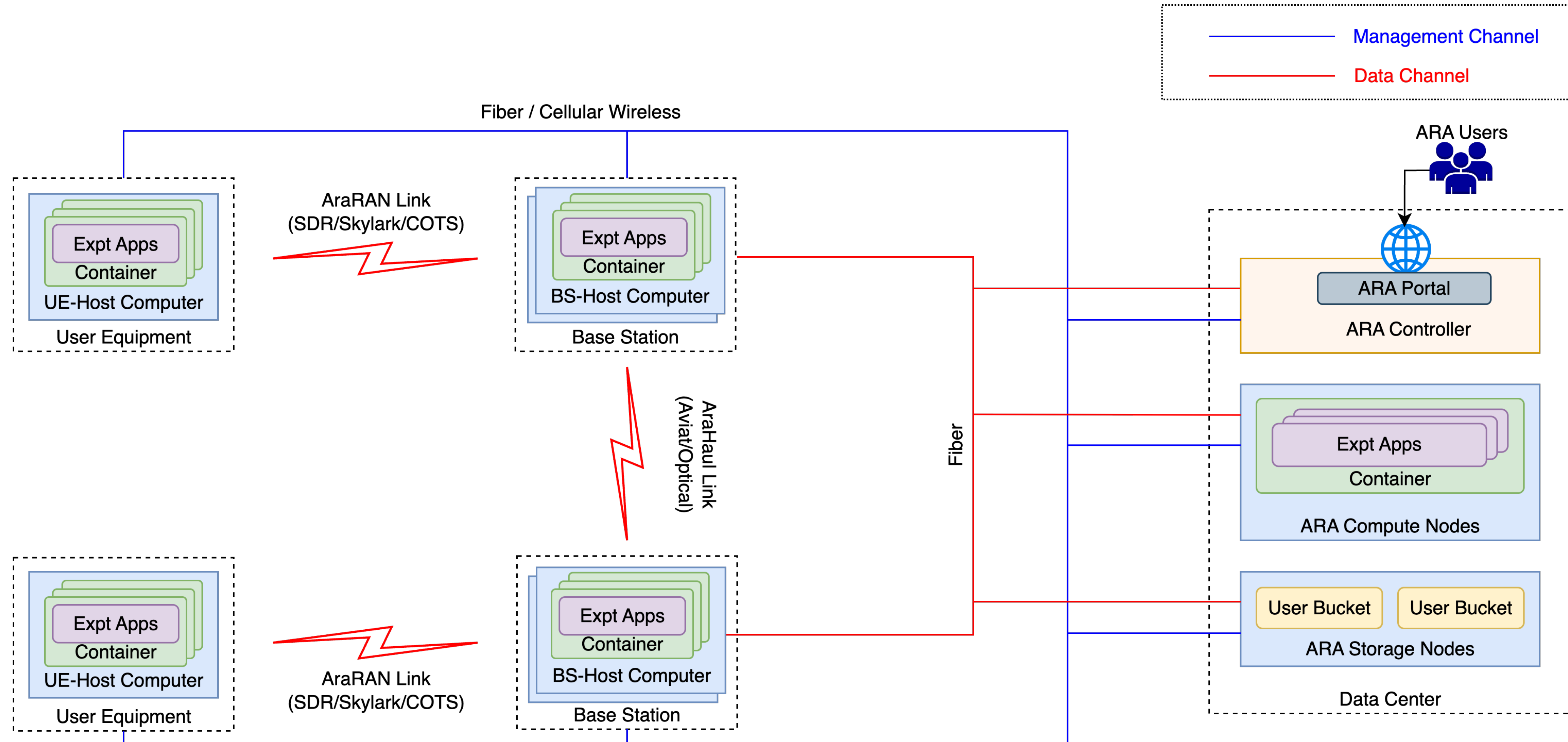


ARA • Experiment Resource

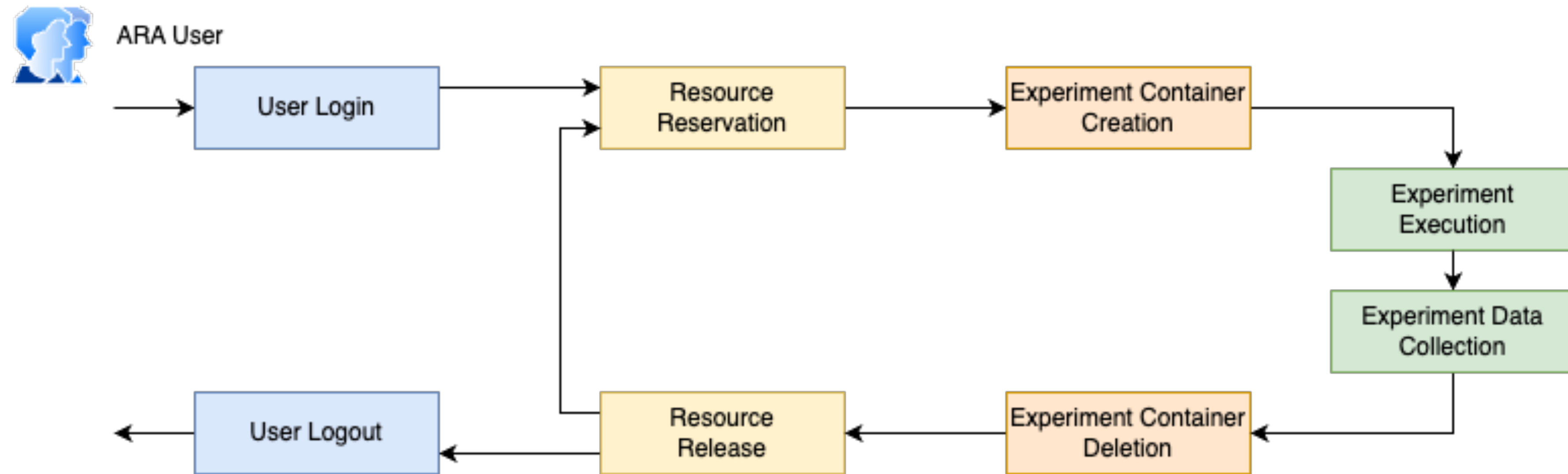
- Resources include compute, access networks (**AraRAN**) radios, x-haul (**AraHaul**) radios, weather sensors, and energy sensors
- Resource in ARA is specified as **DeploymentSite-DeviceType-DeviceID**



ARA • Software Architecture



ARA • Experiment Workflow



User Login

- **Keystone-based Login**
 - Using username and password
- **Federated login using GlobusAuth**
 - Using institute identity credentials

Resource Reservation

- **Using resource attributes**
 - Deployment Site
 - Resource Type
 - Device Type
 - Device ID

Experiment Container Provisioning

- Using Docker containers
- Images from DockerHub
- Access to shell/command prompt
- Access to wireless resources

ARA • Example Experiments

- ARA provides 19 example experiments spanning AraRAN, AraHaul, and Compute/Edge

Resource Used	Experiment	Count
Compute & Edge Nodes	Hello World, Edge	2
	GNURadio experiments	1
AraRAN	MIMO experiments	3
	5G RAN – OpenAirInterface	2 (1 outdoor + 1 indoor)
	RAN - srsRAN	2 (1 indoor + 1 outdoor)
	Spectrum Sensing	1
	COTS channel measurement	1
	O-RAN with FlexRIC	1
AraHaul	Microwave and mmWave link	2
	Free Space Optical link	2
	Satellite backhaul	1
Weather Sensors	Fine-grained weather collection	1

ARA • Experiment Automation using Profiles

- Uses OpenStack **Heat orchestration** feature
- Experiments are specified in a YAML file
- A static approach for experiment automation
- Experiments can be shared to the community as a simple

YAML file

- Workflow

Launch YAML profile -> Experiment Execution -> Profile

Deletion

```
heat_template_version: '2015-04-30'
resources:
  lease_0:
    type: OS::Blazar::Lease
    properties:
      start_date: ''
      end_date: ''
      name: Demo_Lease
      reservations:
        - resource_properties:
            - Site: DataCenter
              Resource_Type: ComputeNode
              Device_Type: Compute
              Device_ID: '000'
  container_0:
    type: OS::Zun::Container
    depends_on:
      - lease_0
    properties:
      command: bash
      image: arawirelesshub/ara-ubuntu:22.04
      name: Demo_Container
      hints:
        host_name: DataCenter-Compute-000
    networks:
      - network: ARA_Shared_Net
```

ARA • Experiment Automation using Jupyter Notebooks



- Uses **araclient** Python library
- APIs for each phase of experiment workflow
 - `demo_lease_ob = araclient.create_lease( demo_lease_info )`
 - `demo_lease_ob.create_container ( container_info )`
 - `demo_container_ob.execute( command )`
 - `demo_container_ob.delete( )`
 - `demo_lease_ob.delete( )`

```
[ ]: import araclient

[ ]: demo_lease_info = {
      'lease_name': 'Demo_Lease_1',
      'start_date': '',
      'end_date': '',
      'site': 'Sandbox',
      'resource_type': 'AraRAN',
      'device_type': 'Host',
      'device_id': '001',
      'center_frequency': '',
      'bandwidth': ''
    }
demo_lease_ob = araclient.create_lease(demo_lease_info)

[ ]: print(demo_lease_ob)

[ ]: demo_lease_ob.get_lease_status()
print(demo_lease_ob)

[ ]: leases = araclient.list_lease()
print(leases)

[ ]: demo_container_ob = demo_lease_ob.create_container('demo_container', 'arawirelesshub/ara-ubuntu:22.04', 'bash', 'ARA_Shared_Net')
print(demo_container_ob)

[ ]: print(demo_container_ob.get_container_status())

[ ]: containers = araclient.list_container()
print(containers)

[ ]: output = demo_container_ob.execute('ls /')
print(output)

[ ]: demo_container_ob.delete()

[ ]: demo_lease_ob.delete()

[ ]:
```

ARA • Resources

- ARA Portal
 - <https://portal.arawireless.org/>
- ARA User Manual
 - <https://arawireless.readthedocs.io/>
- ARA Contact
 - e2@arawireless.org
- ARA User Groups and Discussions
 - ara-users@googlegroups.com
 - ARA Office Hours, Tuesdays 5:00 - 5:30 PM (US Central Time)
- ARA Help and Issue Support
 - support@arawireless.org
 - ara-support@iastate.edu

Thank you.