



Applications and network measurements for Software Defined Radio on CHI@Edge

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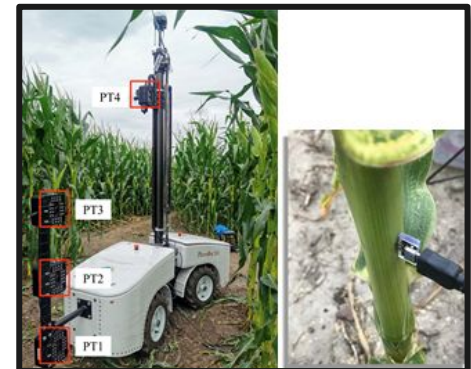
Agenda



- Example Applications at ARA
- Software defined Radio with CHI@Edge
- Experiment Workflow - Demo
- Why CHI@Edge

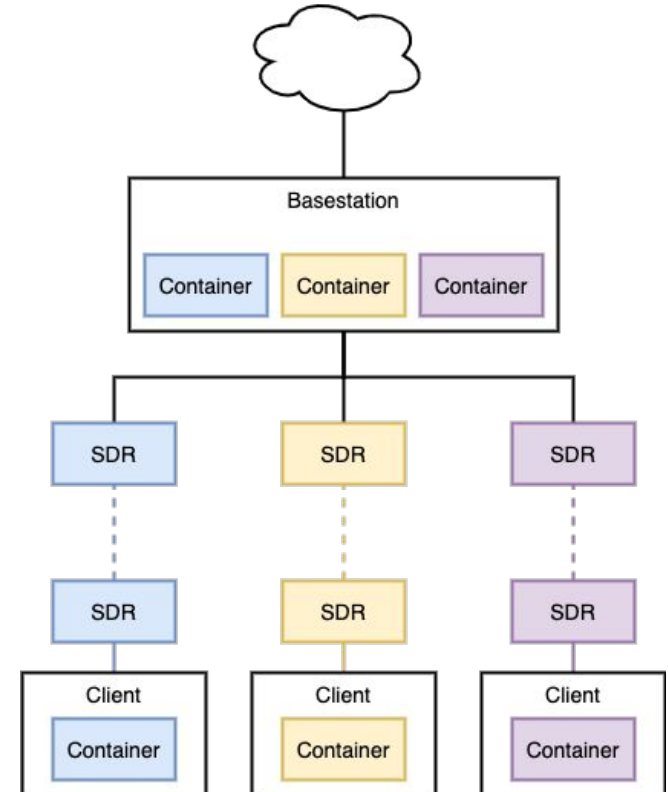
Example Applications

- Agriculture Robot with sensors
 - Real-time, high throughput phenotyping
 - high resolution imaging sensors
 - E.g. [Phenonet](#)
- Transportation
 - Automated vehicle control e.g. Golf cart, etc,
 - Control information over wireless link
 - Real time control
- Precision LiveStock Farming
 - Individual animal behaviour patterns - Animal welfare
- Rural Education
 - AR and VR applications
 - Connecting classrooms to the fields
 - Rural STEM education



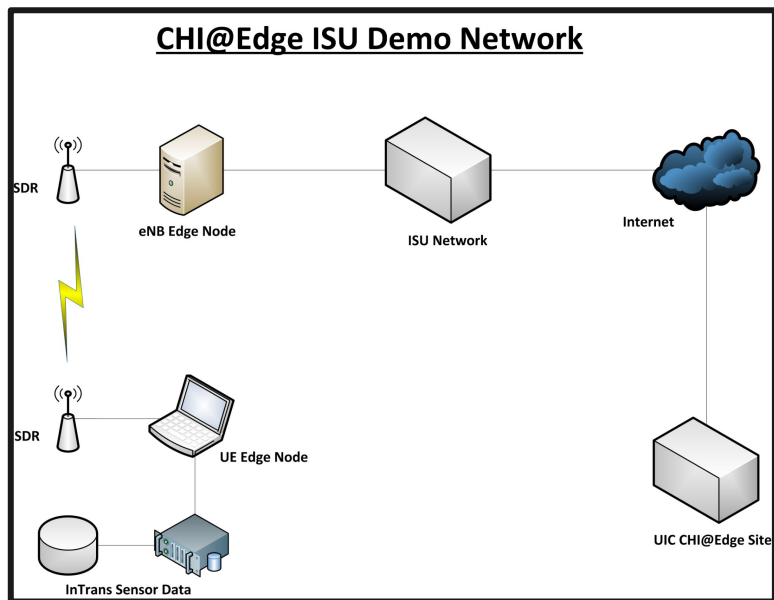
Example Applications (Cont.)

- Wireless Experiments
 - Channel sounding
 - Massive MIMO
 - mmWave
 - System studies
 - Spectrum Innovation
 - Other Wireless networks studies
- Orchestration and resource virtualization



Experiment Workflow (demo)

- User reserve eNB & UE Nodes
- User Launch containers
- Run protocol stack
- Results



```

47 15 0 0.0 0 0 0 0% 30.6 9.50 40.0 12 4.5k 3 0 0% 0.0
47 15 0 0.0 0 0 0 0% 0.0 10.1 0.0 0 0 0 0 0% 0.0
47 15 0 0.0 0 0 0 0% 0.0 9.67 0.0 0 0 0 0 0% 0.0
47 15 0 0.0 0 0 0 0% 0.0 10.1 0.0 0 0 0 0 0% 0.0
47 15 0 0.0 0 0 0 0% 0.0 9.76 0.0 0 0 0 0 0% 0.0
47 15 0 23 286k 13 0 0% 31.6 13.5 40.0 15 82k 33 2 5.7k 0.0
47 15 0 26 3.9M 89 0 0% 32.8 19.0 40.0 18 539k 131 12 8.4k 0.0

-----DL-----
rnti cqi ri mcs brate ok nok (%) pusch pucch phr mcs brate ok nok (%) bsr
47 15 0 27 9.7M 185 0 0% 31.8 19.3 40.0 19 1.1M 208 2310.0k 0.0
47 15 0 27 21M 326 1 0.3% 28.8 21.4 40.0 20 2.0M 217 33 13k 245
47 15 0 28 40M 563 2 0.4% 22.3 23.1 40.0 16 3.5M 316 65 17k 1.38k
47 15 0 27 6.1M 102 0 0% 29.4 18.9 40.0 17 869k 99 15 13k 0.0
47 15 0 26 4.6M 112 0 0% 33.8 19.1 40.0 19 681k 168 11 6.1k 0.0
47 15 0 27 11M 193 0 0% 31.0 19.1 40.0 19 1.2M 203 22 9.8k 0.0
47 15 0 27 24M 362 0 0% 28.0 21.5 40.0 19 2.2M 252 44 15k 0.0
47 15 0 27 22M 335 0 0% 27.1 22.1 40.0 20 1.9M 210 46 18k 0.0
47 15 0 25 2.3M 50 0 0% 29.9 14.1 40.0 19 345k 61 5 7.0k 0.0
47 15 0 26 4.9M 115 0 0% 33.1 16.3 40.0 19 655k 161 14 8.0k 0.0
47 15 0 27 12M 220 0 0% 32.4 19.7 40.0 20 1.2M 220 23 9.5k 0.0

-----DL-----
rnti cqi ri mcs brate ok nok (%) pusch pucch phr mcs brate ok nok (%) bsr
47 15 0 28 27M 396 0 0% 27.5 21.8 40.0 19 2.5M 242 44 15k 205
47 15 0 28 29M 404 0 0% 25.2 22.3 40.0 20 2.9M 187 48 20k 0.0
47 15 0 25 1.2M 34 0 0% 30.9 16.8 40.0 17 251k 65 4 5.8k 0.0
47 15 0 26 5.3M 118 0 0% 32.1 17.8 40.0 20 682k 170 21 11k 0.0
47 15 0 27 11M 198 0 0% 32.6 19.5 40.0 19 1.1M 227 19 7.7k 0.0
47 15 0 27 13M 207 2 1.0% 31.8 20.4 40.0 19 1.2M 166 26 14k 0.0

-----Signal-----
cc pci rsrp pl cfo mcs snr iter brate bler ta_us mcs buff brate bler
0 1 -44 44 -2.4k | 20 39 0.5 6.1k 0% 0.5 | 0 0.0 0.0 0%
0 1 -45 45 -2.4k | 20 39 0.5 6.1k 0% 0.5 | 13 0.0 18k 0%
0 1 -47 47 -2.4k | 25 38 0.5 2.9M 0% 0.5 | 17 2.1k 367k 5%
0 1 -48 48 -2.4k | 26 38 0.5 7.7M 0% 0.5 | 18 4.1k 933k 6%
0 1 -47 47 -2.4k | 27 36 0.5 16M 0% 0.5 | 19 560 1.8M 11%
0 1 -45 45 -2.4k | 27 35 0.6 38M 0% 0.5 | 16 8.1k 3.7M 11%
0 1 -45 45 -2.4k | 27 37 0.6 14M 0% 0.5 | 17 0.0 1.7M 13%
0 1 -42 42 -2.4k | 25 38 0.5 3.7M 0% 0.5 | 18 0.0 491k 3%

-----Signal-----
cc pci rsrp pl cfo mcs snr iter brate bler ta_us mcs buff brate bler
0 1 -49 49 -2.4k | 26 37 0.5 8.7M 0% 0.5 | 18 4.2k 1.0M 5%
0 1 -49 49 -2.4k | 27 36 0.5 20M 0% 0.5 | 19 2.1k 2.3M 11%
0 1 -49 49 -2.4k | 27 36 0.6 22M 0% 0.5 | 19 1.1k 2.3M 12%
0 1 -46 46 -2.4k | 26 37 0.6 7.3M 0% 0.5 | 19 0.0 741k 11%
0 1 -46 46 -2.4k | 25 38 0.5 3.8M 0% 0.5 | 19 353 516k 4%
0 1 -44 44 -2.4k | 26 37 0.5 9.8M 0% 0.5 | 19 560 1.0M 6%
0 1 -46 46 -2.4k | 27 36 0.6 22M 0% 0.5 | 19 5.9k 2.3M 10%
0 1 -46 46 -2.4k | 27 36 0.6 31M 0% 0.5 | 19 0.0 3.6M 14%
0 1 -46 46 -2.4k | 27 37 0.5 5.5M 0% 0.5 | 17 0.0 466k 6%
0 1 -45 45 -2.4k | 25 38 0.5 3.9M 0% 0.5 | 18 506 505k 6%
0 1 -46 46 -2.4k | 26 37 0.5 10M 0% 0.5 | 19 0.0 1.1M 5%

-----Signal-----
cc pci rsrp pl cfo mcs snr iter brate bler ta_us mcs buff brate bler
0 1 -46 46 -2.4k | 26 37 0.6 13M 0% 0.5 | 19 5.5k 1.4M 8%

```

Containers - ChameleonCloud x JupyterLab x +

[←](#)
[→](#)
[C](#)
[jupyter.chameleoncloud.org/user/shermamm@uchicago.edu/lab/tree/chci-edge-scripts/SDR...](#)

File Edit View Run Kernel Share Tabs Settings Help

Untitled.ipynb x sdr_test.ipynb ● cc@iperf-server-tacc: ~ x

Python 3

```

[!]= server_info = {"url": tacc_attached_ip, "port": "52202"}
timeout = "4"
interval = "1"

for trial in range(0,20):
    output_dict = container.execute(
        my_container.uid,
        f"iperf3 -t {timeout} -c {server_info['url']} -p {server_info['port']} -R ")
    print(output_dict.get('output'))

Connecting to host 129.114.109.245, port 52202
Reverse mode, remote host 129.114.109.245 is sending
[ S] local 10.0.2.97 port 56904 connected to 129.114.109.245 port 52202
[ ID] Interval      Transfer     Bitrate
[ S] 0.00-1.00 sec   369 KBytes   3.02 Mbits/sec
[ S] 1.00-2.00 sec   943 KBytes   7.73 Mbits/sec
[ S] 2.00-3.00 sec   1.99 MBytes  16.7 Mbits/sec
[ S] 3.00-4.00 sec   4.12 MBytes  34.6 Mbits/sec

[ ID] Interval      Transfer     Bitrate      Retr
[ S] 0.00-4.04 sec   9.32 MBytes  19.4 Mbits/sec    19
[ S] 0.00-4.00 sec   7.40 MBytes  15.5 Mbits/sec

iperf Done.

Connecting to host 129.114.109.245, port 52202
Reverse mode, remote host 129.114.109.245 is sending
[ S] local 10.0.2.97 port 57376 connected to 129.114.109.245 port 52202
[ ID] Interval      Transfer     Bitrate
[ S] 0.00-1.00 sec   483 KBytes   3.30 Mbits/sec
[ S] 1.00-2.00 sec   947 KBytes   7.76 Mbits/sec
[ S] 2.00-3.00 sec   2.18 MBytes  18.3 Mbits/sec
[ S] 3.00-4.00 sec   2.32 MBytes  19.5 Mbits/sec

[ ID] Interval      Transfer     Bitrate      Retr
[ S] 0.00-4.06 sec   6.95 MBytes  14.4 Mbits/sec     0
[ S] 0.00-4.00 sec   5.83 MBytes  12.2 Mbits/sec

iperf Done.

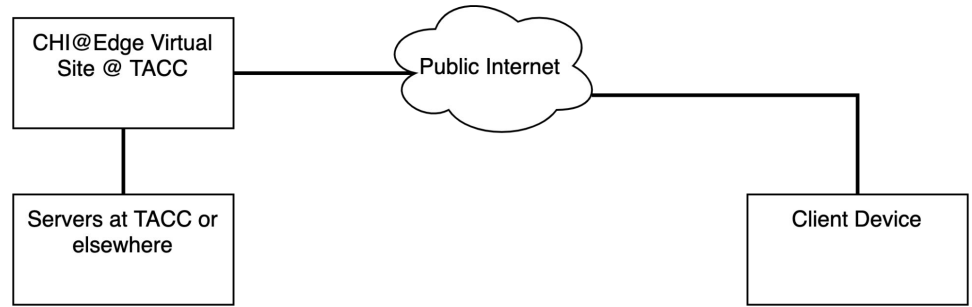
Connecting to host 129.114.109.245, port 52202
Reverse mode, remote host 129.114.109.245 is sending
[ S] local 10.0.2.97 port 57848 connected to 129.114.109.245 port 52202
[ ID] Interval      Transfer     Bitrate
[ S] 0.00-1.00 sec   382 KBytes   3.13 Mbits/sec
[ S] 1.00-2.00 sec   953 KBytes   7.81 Mbits/sec
[ S] 2.00-3.00 sec   2.13 MBytes  17.9 Mbits/sec
[ S] 3.00-4.00 sec   3.33 MBytes  27.9 Mbits/sec

```

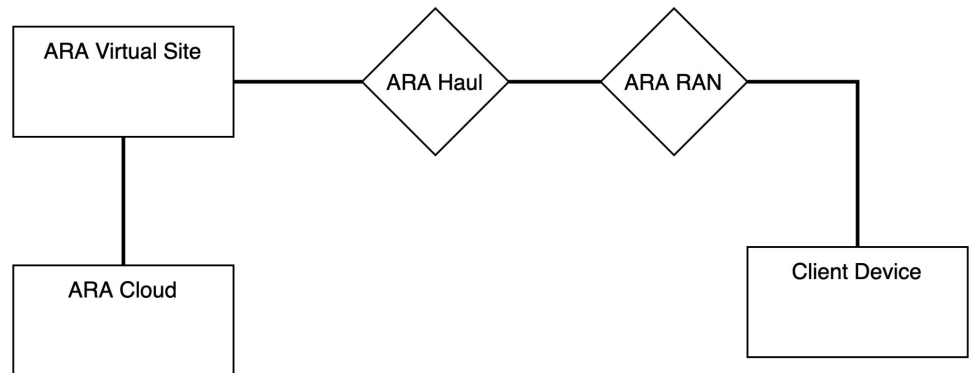
Simple 3 2 Python 3 Busy Saving completed Mode: Command Ln 1, Col 1 sdr_test.ipynb

Network Measurements vs. Network Control

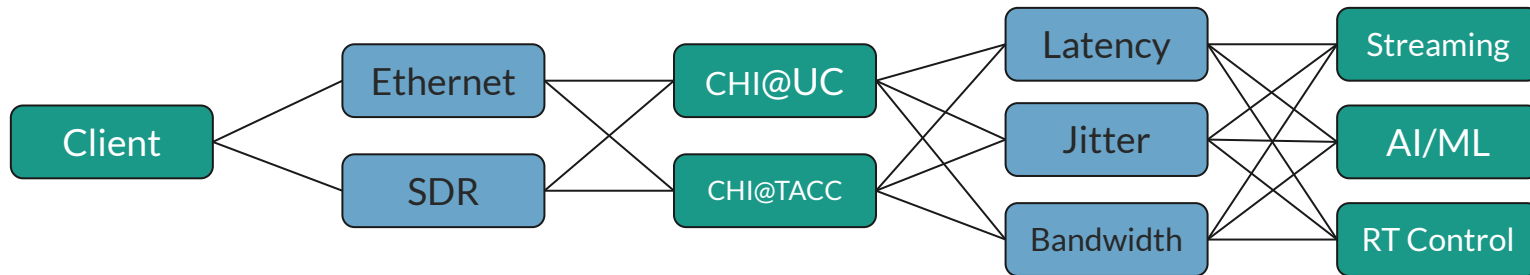
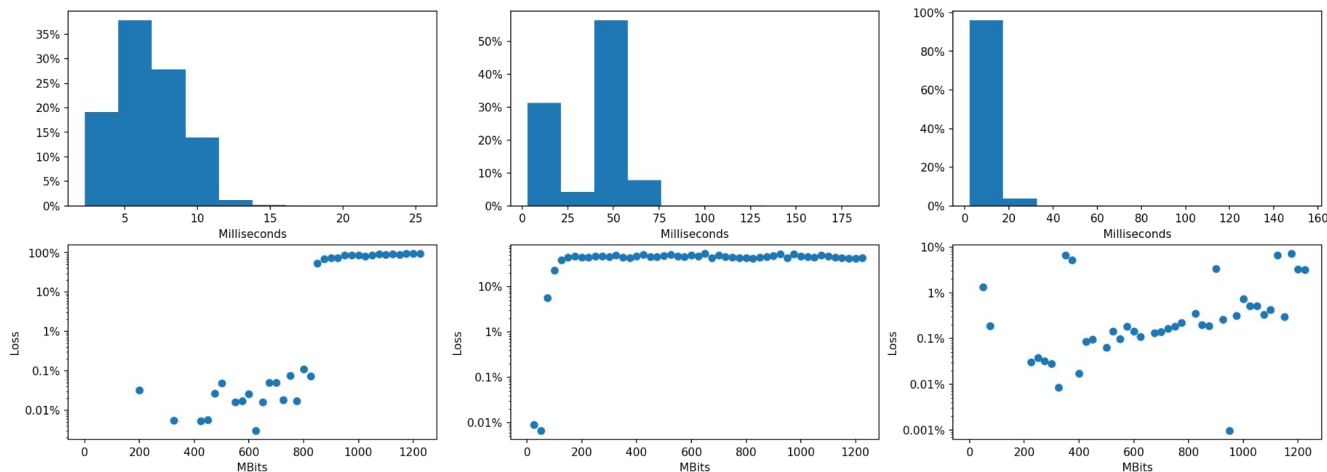
- Edge device to cloud
- Last mile problem
- Measure the connection properties



- Deployment at ARA will control the full path



Results From Current Deployment



Why CHI@Edge



- Infrastructure Virtualization
 - Parallel experiments
 - Parallel Computing Resource usage
- Minimize Latency - Real time applications
 - Edge (eNB computing resources)
 - Edge - cloud (near)
 - Edge - cloud (far)
- Parametrize Experiments
 - Frequency, Resource Blocks, Tx Power etc.
- Share premade images for srsRAN, OpenAirInterface, GNURadio
 - Base case should “just work”, default configuration
 - Reuse same container with different configuration files
 - Allow experimenters to get started quickly