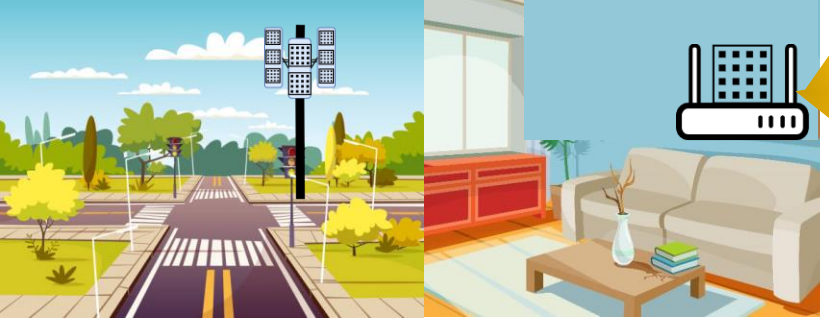

UC San Diego
Electrical and Computer Engineering
JACOBS SCHOOL OF ENGINEERING

BeamArmor: Seamless Anti-Jamming in 5G Cellular Networks with MIMO Null-steering

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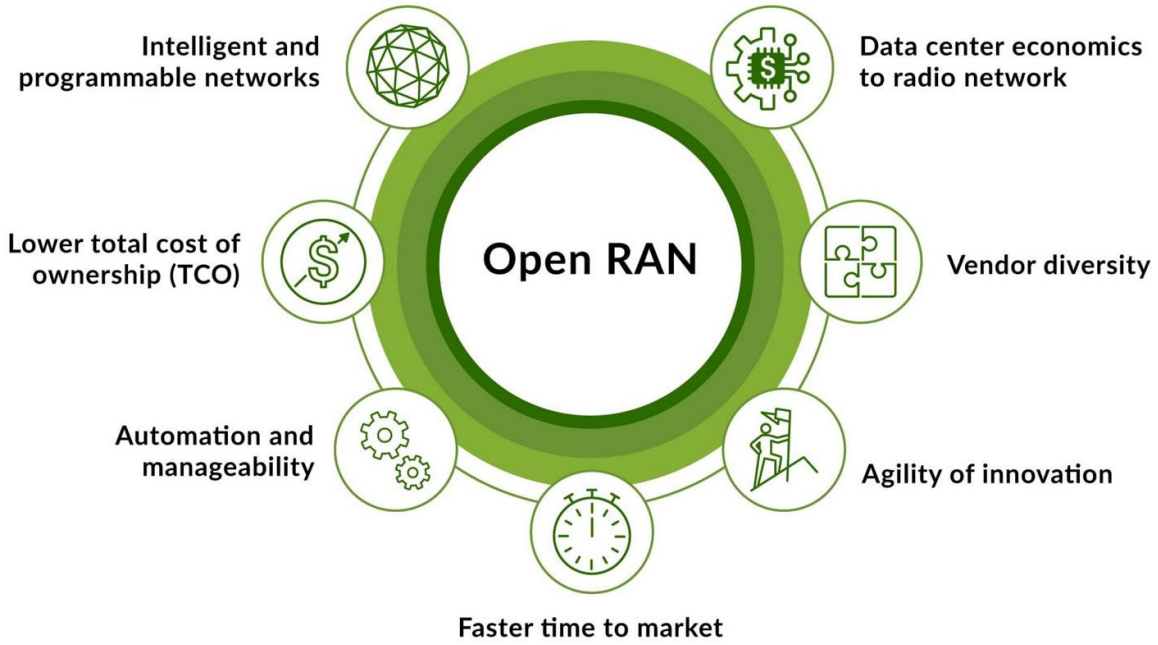
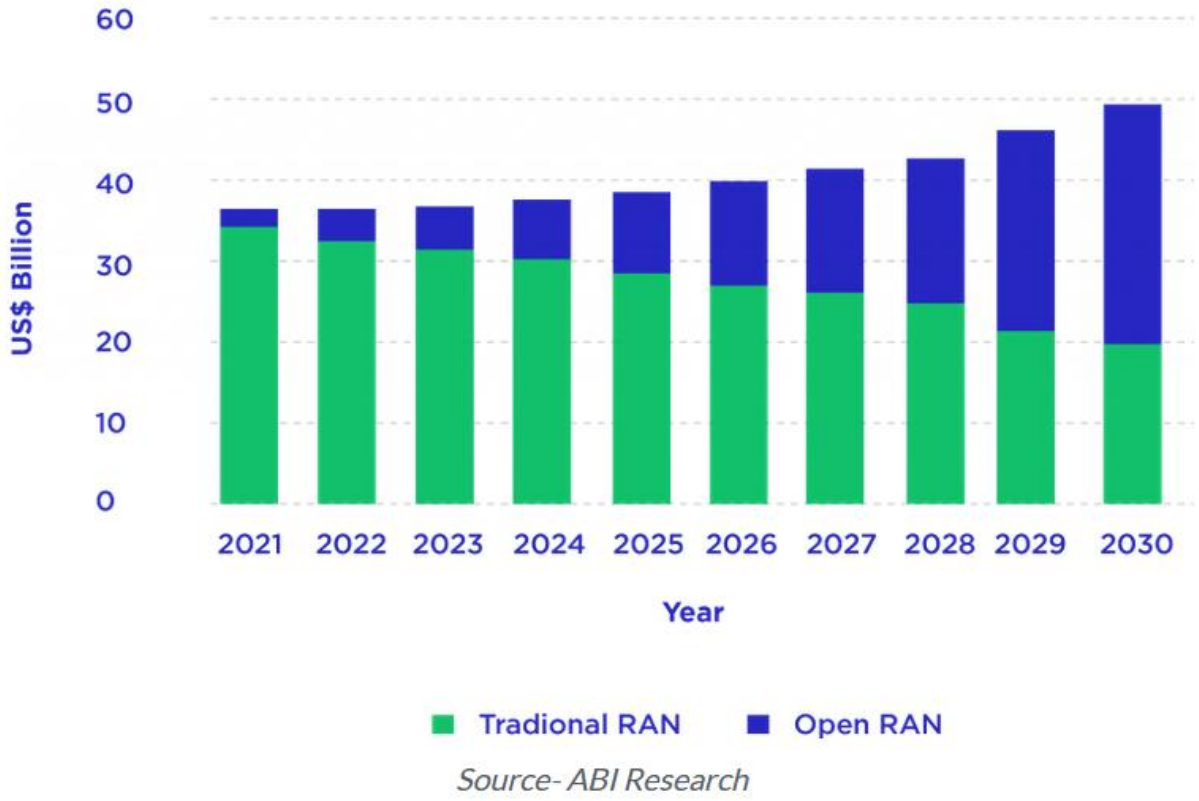
University of California San Diego, *ETH Zurich

HotMobile 2024 San Diego California 2/29/24

Open-RAN brings Revolution for NextG Networks



Source- Juniper.net



Source- ABI Research

Analogy for Open-RAN

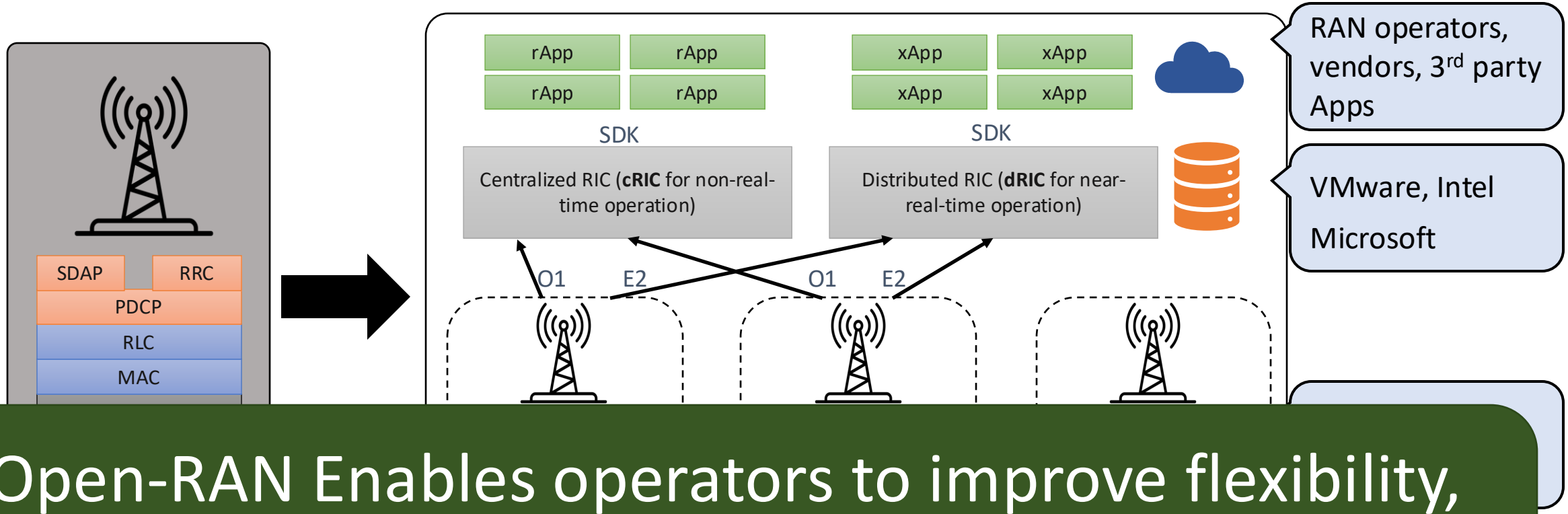
Apps

ANDROID

iOS

Hardware

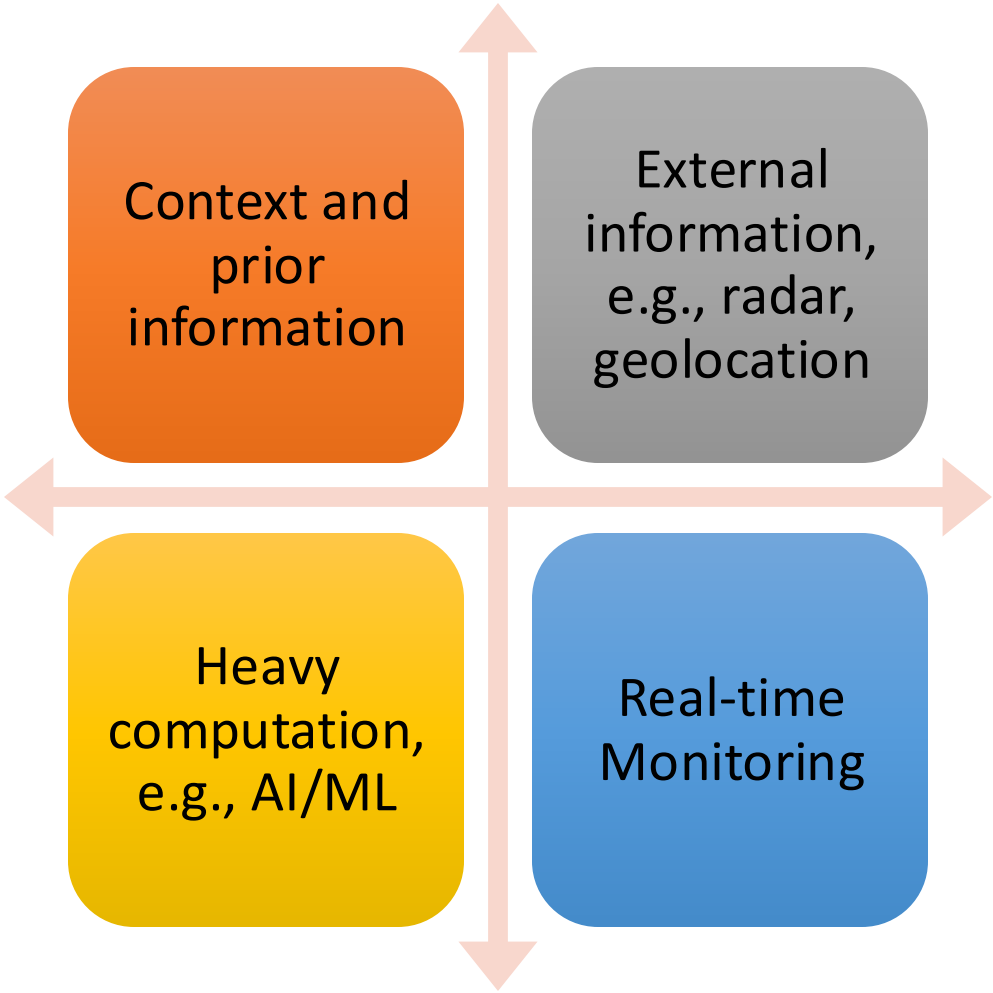
What is Open-RAN?



Open-RAN Enables operators to improve flexibility, customizability, agility, & performance in RAN

Anyone can be an xApp developer?

An xApp provides many features not available in traditional RAN



State-of-the-art RAN Controllers

Janus Controller [Mobicom'23, Microsoft]

VMWare RIC, **Nokia** RIC

Proprietary, not available for the research community

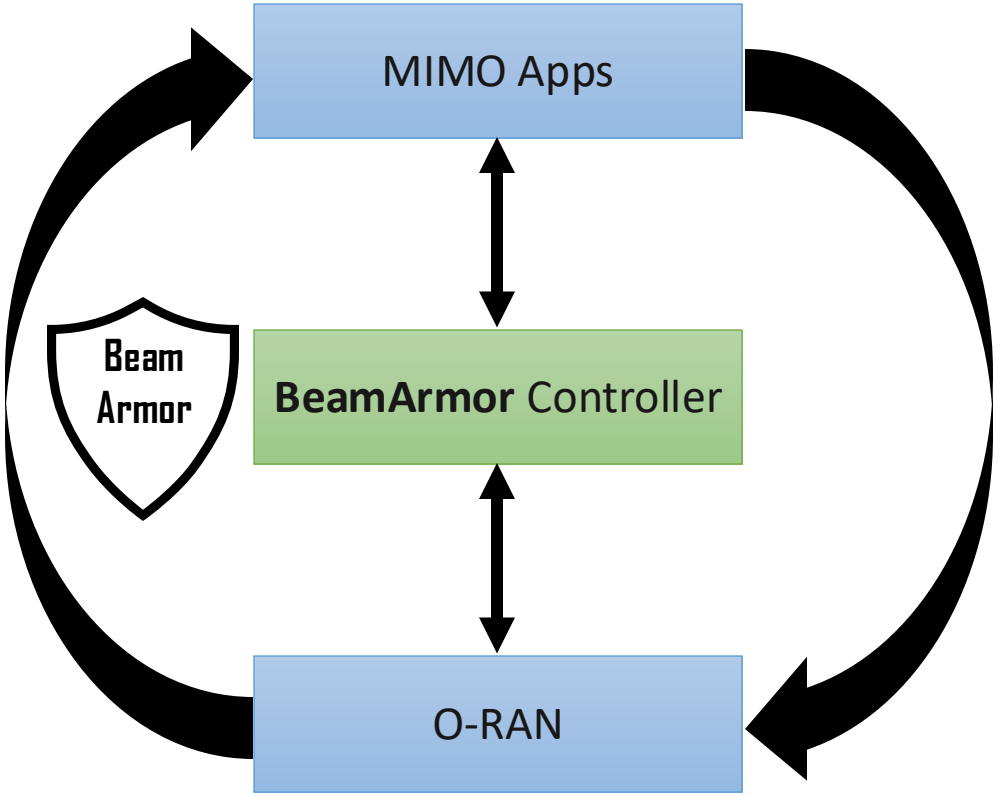
FlexRIC [Conext'21, EURECOM]

OpenSource, but targets specific

Lack of open-source Controllers for PHY layer, e.g., MIMO Applications

BeamArmor: Controller for MIMO Apps

- RAN configuration
- MIMO channels
- Perf. Metrics (KPI), e.g., SINR, BLER, Throughput



- Beamforming/ Beam-nulling
- MIMO user selection
- MIMO antenna selection
- Localization and Tracking

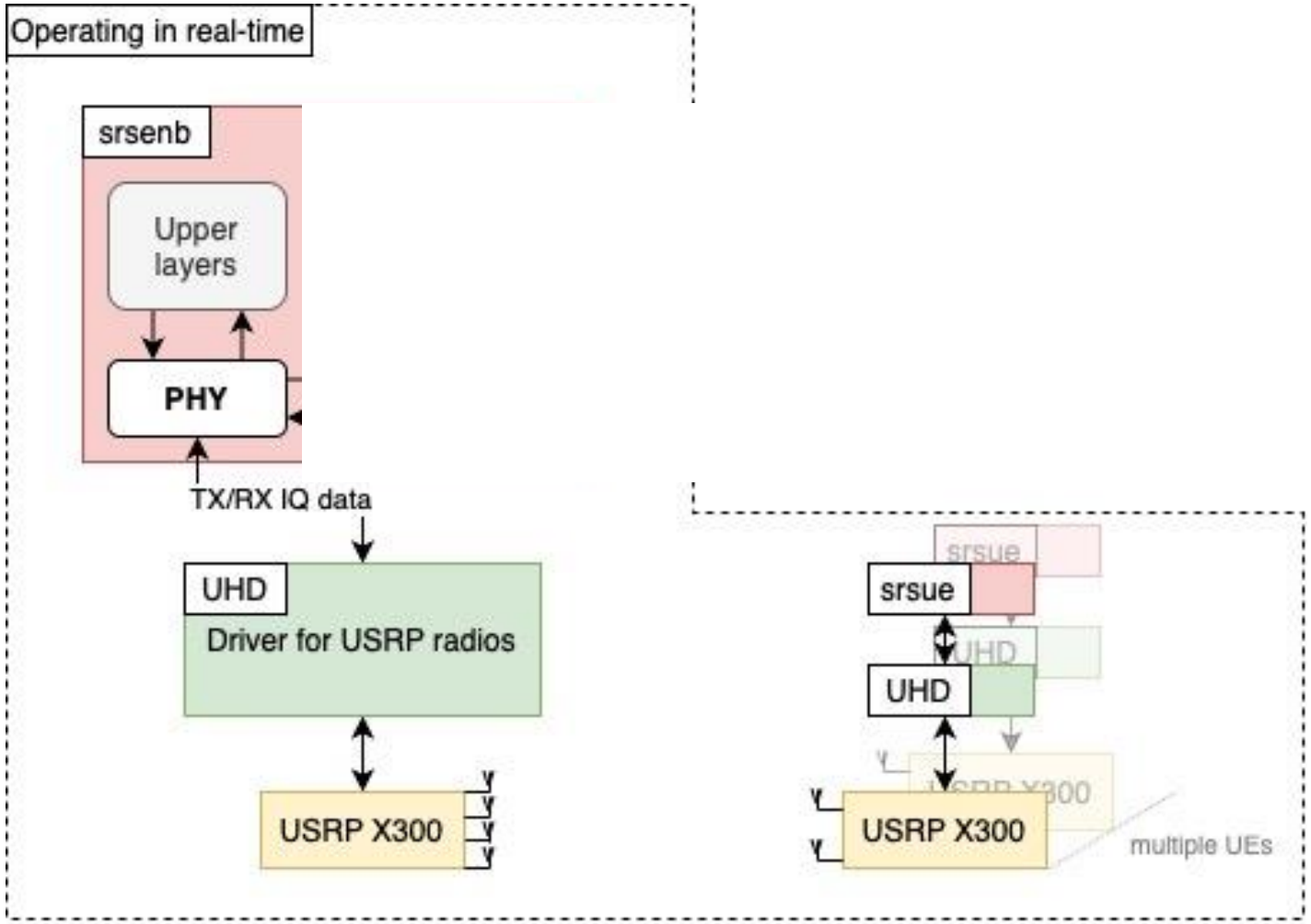
SRS RAN

[Open Source]
https://github.com/ucsdwcsng/beamarmor

Implementation of BeamArmor Controller

Timely operation of PHY layer

- Non-blocking behavior through pub/sub pattern and polling
- Reduced data size through smart downsampling



BeamArmor simplifies App development

```
uhd_error         start_rx_stream(double delay)
{
  Debug("Starting Rx stream");
  // Frederik
  printf("Starting Rx stream\n");
  printf("Number of channels: %ld \n", rx_stream->get_num_channels());
  //
  uhd::time_spec_t time_spec;
  uhd_error        err = get_time_now(time_spec);
  if (err != UHD_ERROR_NONE) {
    return err;
  }

  SRSRAN_UHD_SAFE_C_LOG_ERROR(uhd::stream_cmd_t stream_cmd(uhd::stream
```

```
y1,y2 = get_raw_data()
.
.
send_control_data(α)
```

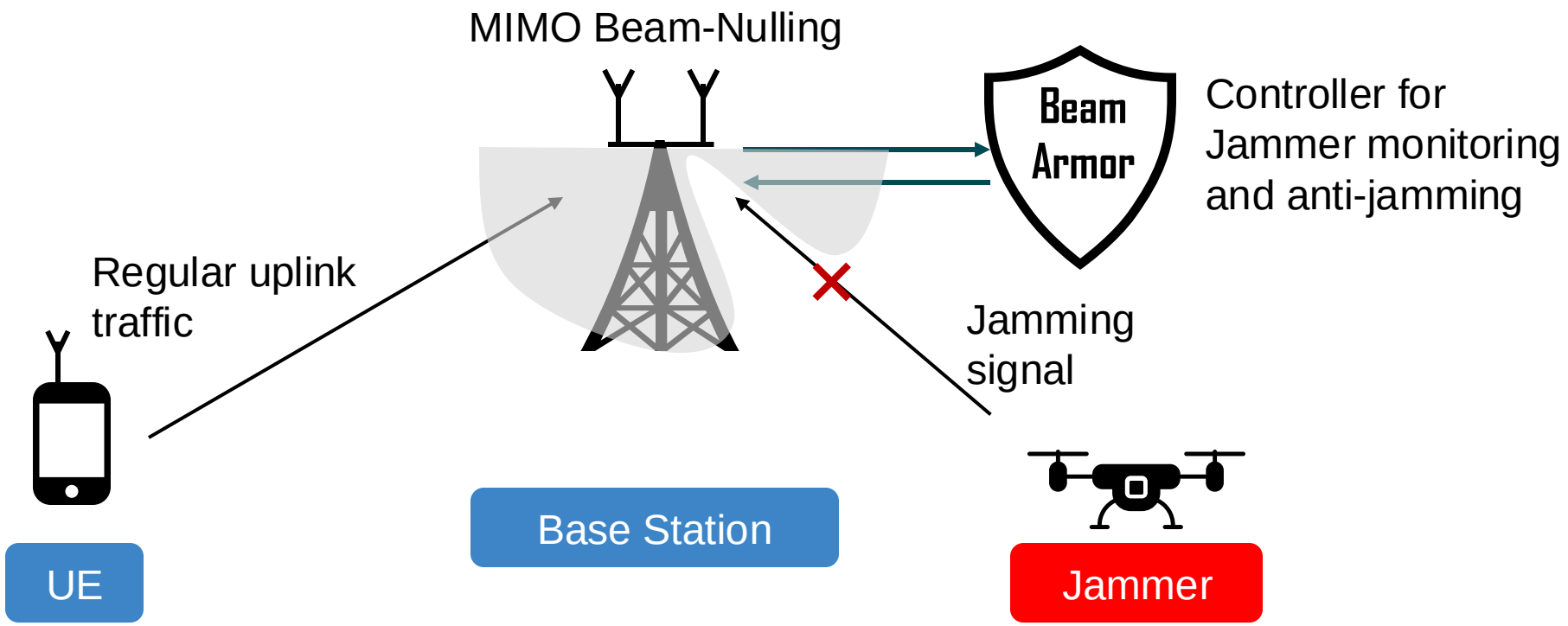
w/o BeamArmor

C/C++ Building an App directly into RAN

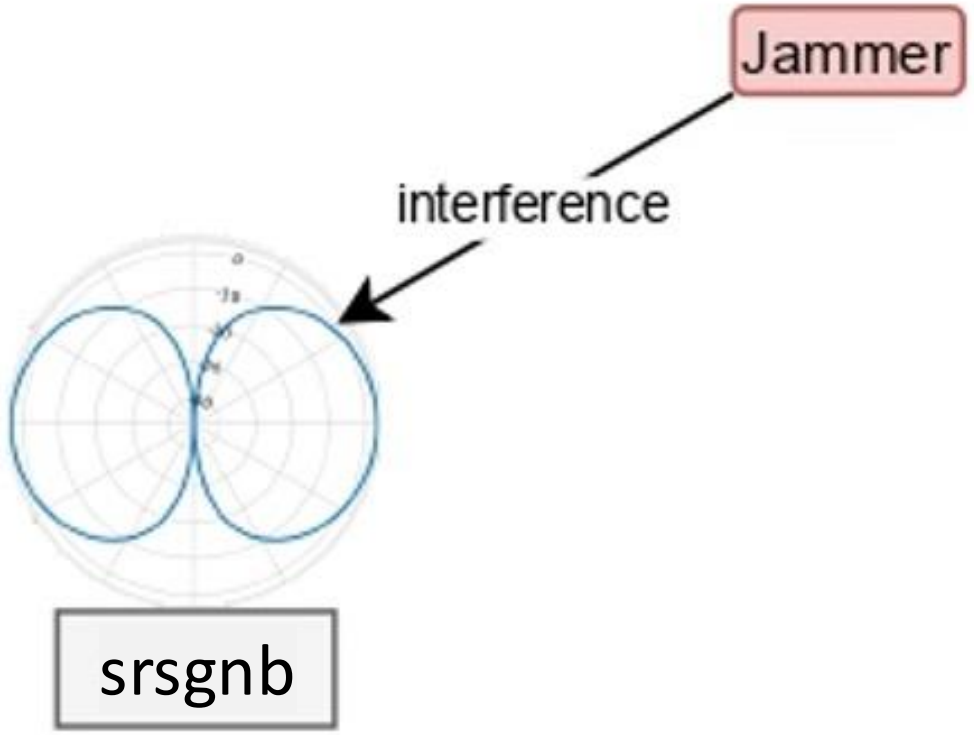
with BeamArmor

Building an App in the controller

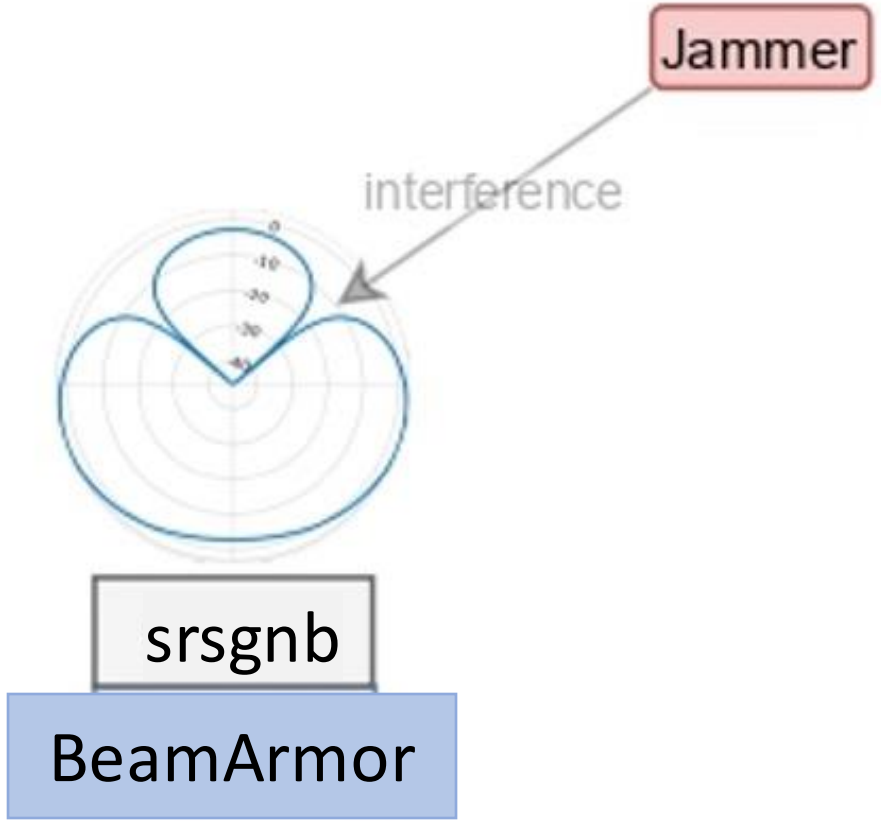
BeamArmor App: Jammer Monitoring and Anti-Jamming



Why Null-steering for Jammer Mitigation?

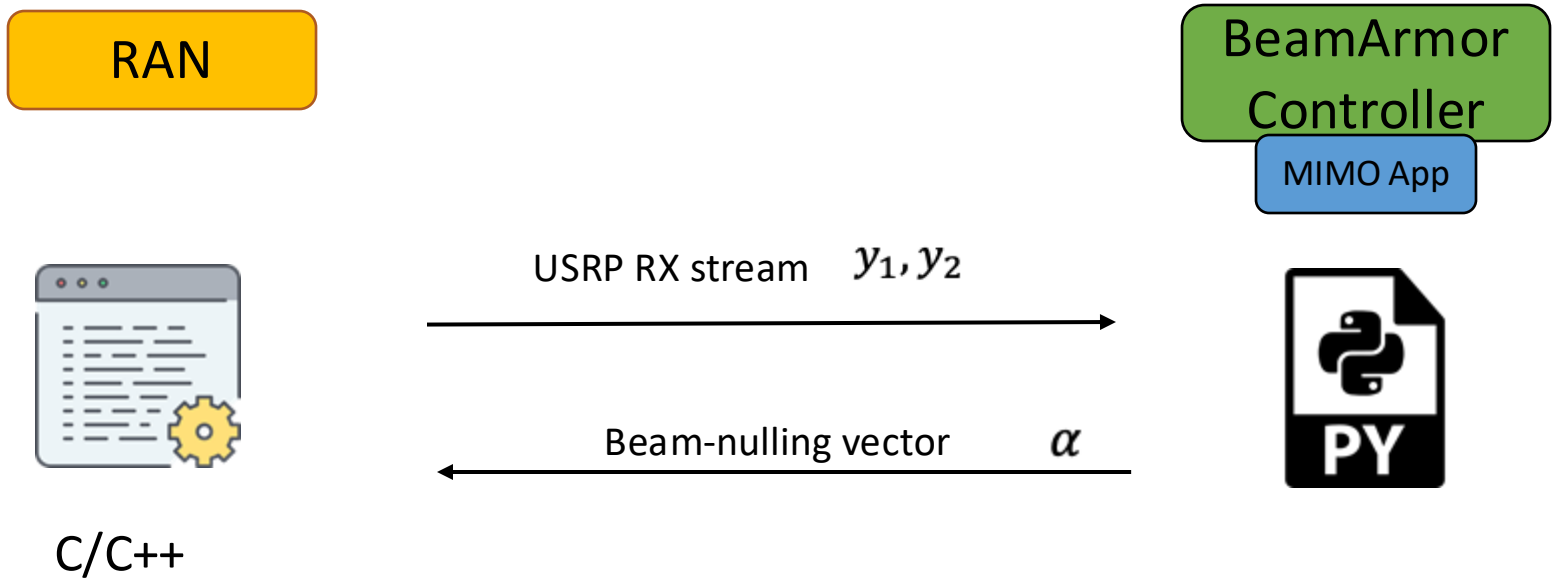


w/o null-steering



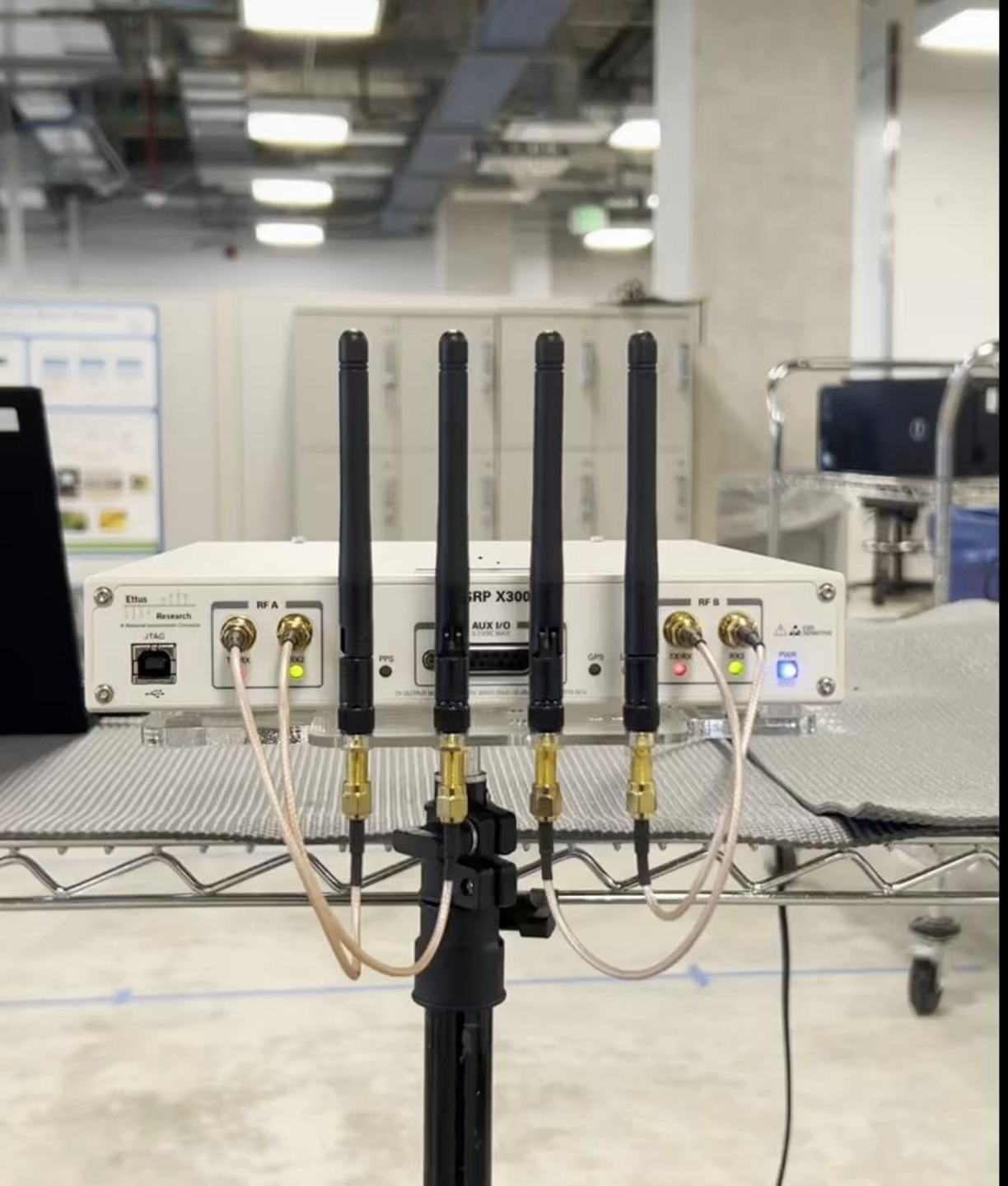
with null-steering

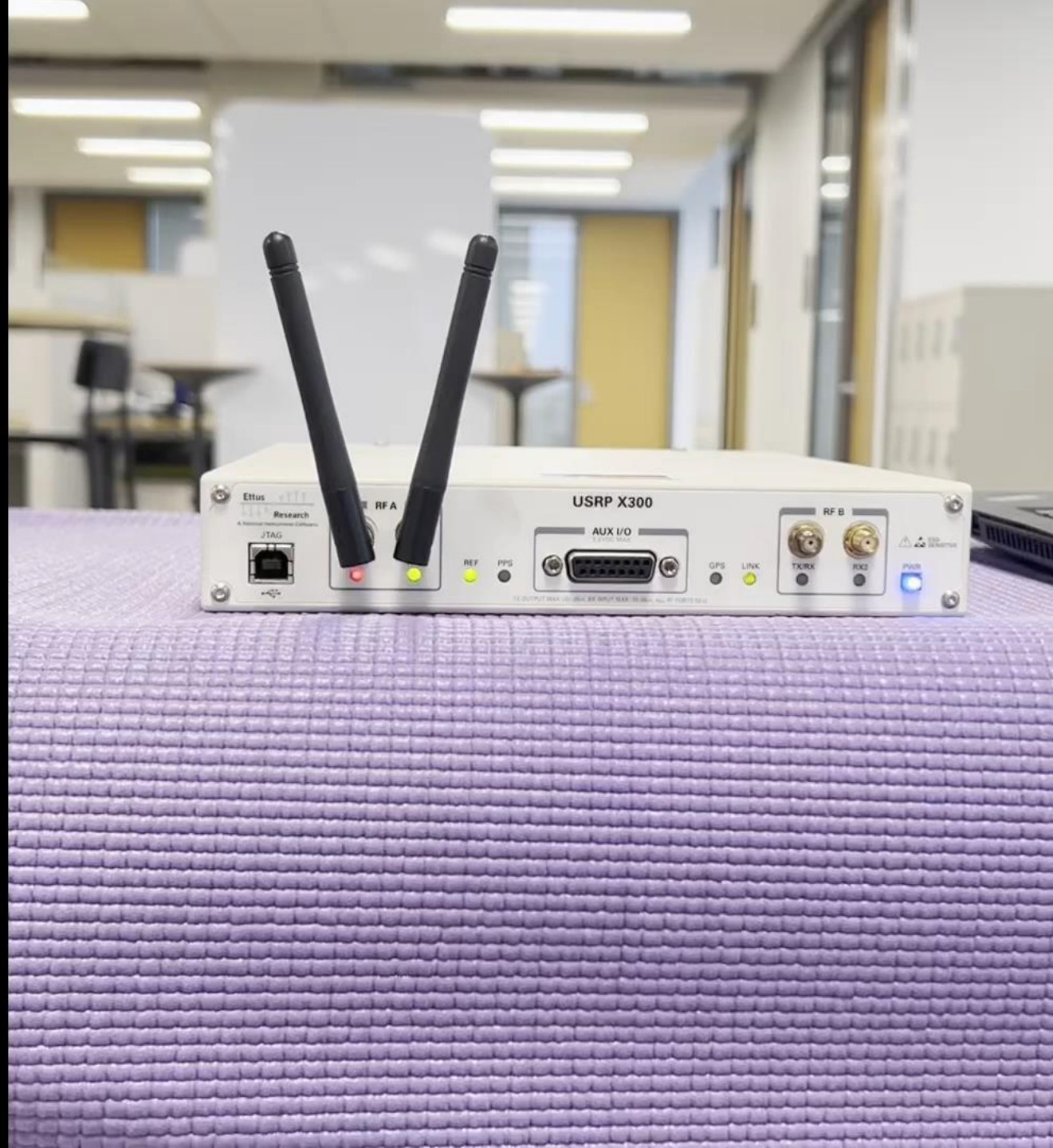
Null-Steering implementation with BeamArmor



$$y^* = \frac{y_1 + \alpha y_2}{\sqrt{1 + \alpha^2}},$$

Apply beam-nulling for UL processing


Ettus
Research
JTAG
RF A
PPS
AUX I/O
GPS
RF B
PWR


Ettus
Research
JTAG
RF A
USRP X300
REF
PPS
AUX I/O
GPS
LINK
RF B
TX/RX
RX2
PWR