Open AI Cellular (OAIC):

Prototyping AI-Enabled Control and Testing Systems for Cellular Communications

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OAIC is an NSF CISE Community Research Infrastructure (CCRI) under development, CNS-2120411 and 2120442.

Today's Agenda

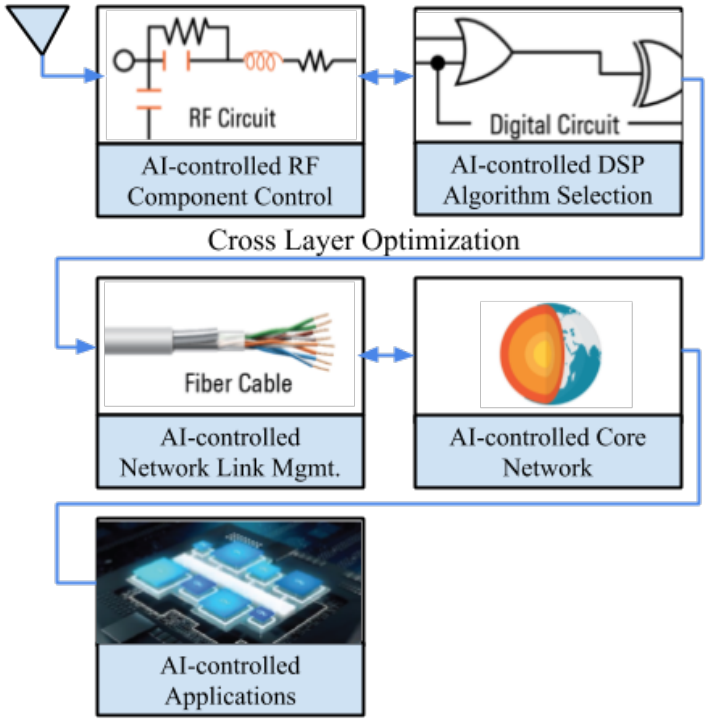
- ~~Background on 5G/Next-G RAN~~
- ~~O-RAN Architecture~~
- Opportunities of AI in 5G/Next-G RAN
- AI Challenges and Motivation for OAIC
- Open AI Cellular (OAIC)
  - Open AI-enabled Cellular RAN controllers (OAIC-C)
  - Open AI-enabled Cellular RAN Testing (OAIC-T) Framework
- Why do I care?
- OAIC Timeline and Roadmap
- Getting Involved?

Opportunities of AI in 5G/Next-G RAN

AI is well suited for wireless communications

- It **can learn and estimate near-optimal settings** in situations that have a large search space – (5G has an estimated 4500 tunable parameters)
- It can **generalize a solution** to respond to new situations
- It can interpolate when **insufficient information is available**

AI-done right in 5G will be the basis for realizing 6G [1]



Beamforming
- DNN
- CNN

Scheduling
- RL/DRL

Spectrum sharing
- RL/DRL
- DEQN

RAN Optimization
- RL/DRL
- LSTM/DEQN
- Fed. Learning

Channel Estimation
- GANs

And …

[1] Letaief, K. B., Chen, W., Shi, Y., Zhang, J., & Zhang, Y. J. A. (2019). The roadmap to 6G: AI empowered wireless networks. IEEE Communications Magazine, 57(8), 84-90.

AI Challenges in 5G/Next-G RAN (and Motivation for OAIC)

While there is lots of optimism in the wireless research community on AI, the reality is that

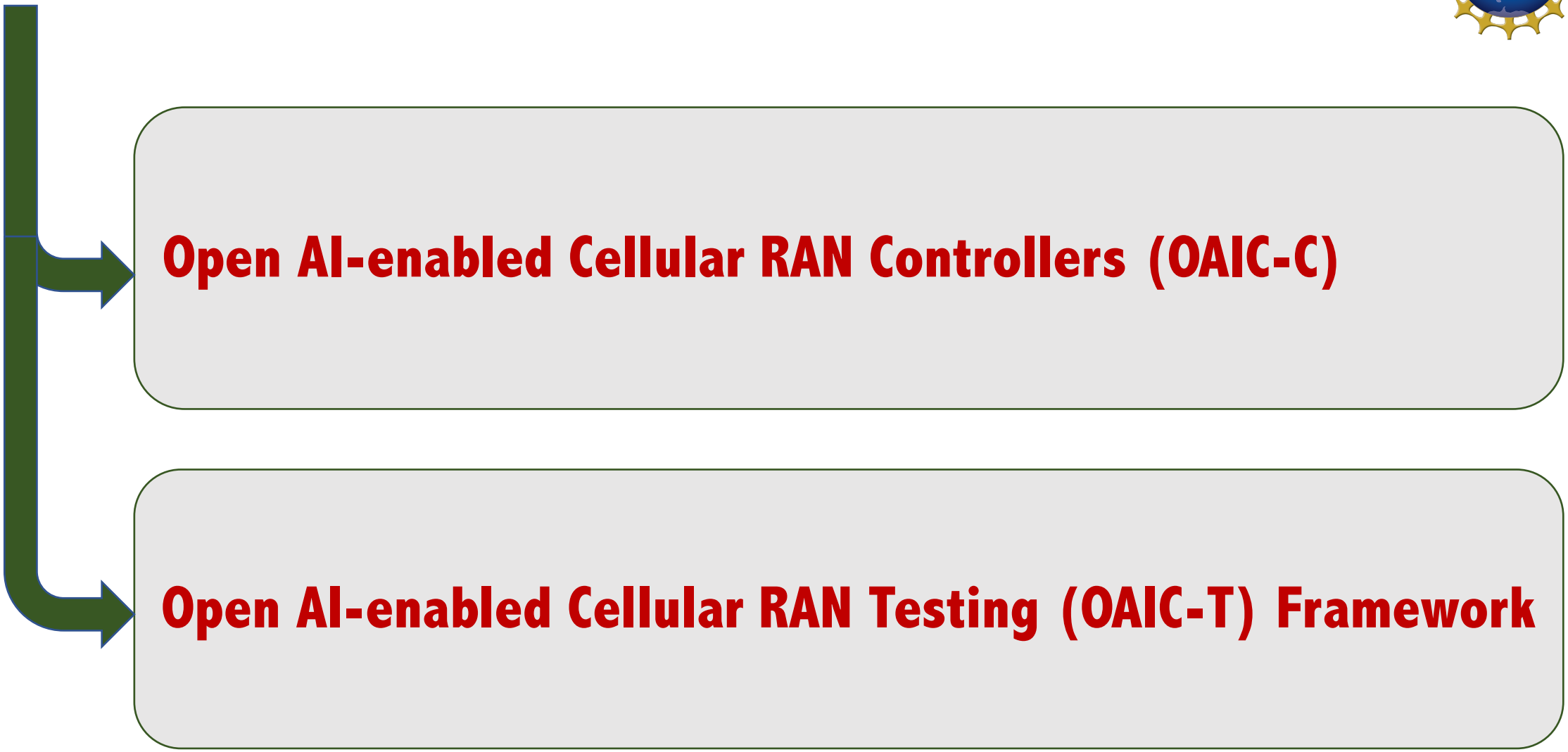
- There needs to be **sufficient real-world experience at scale** to prove the added expense of AI is justified in improved performance.
- AI in the network needs to be **extensively tested** with the rigor that other elements of the network are tested today.

Some key research questions

- How do we design cellular networks to be more AI suitable at various locations?
- What methodologies apply to test AI performance at various locations in the network?
- How do we test for cross-layer interactions of AI deployed at various points in the network?
- Can testing of AI be used to find configuration failures as well as to ensure secure configurations?

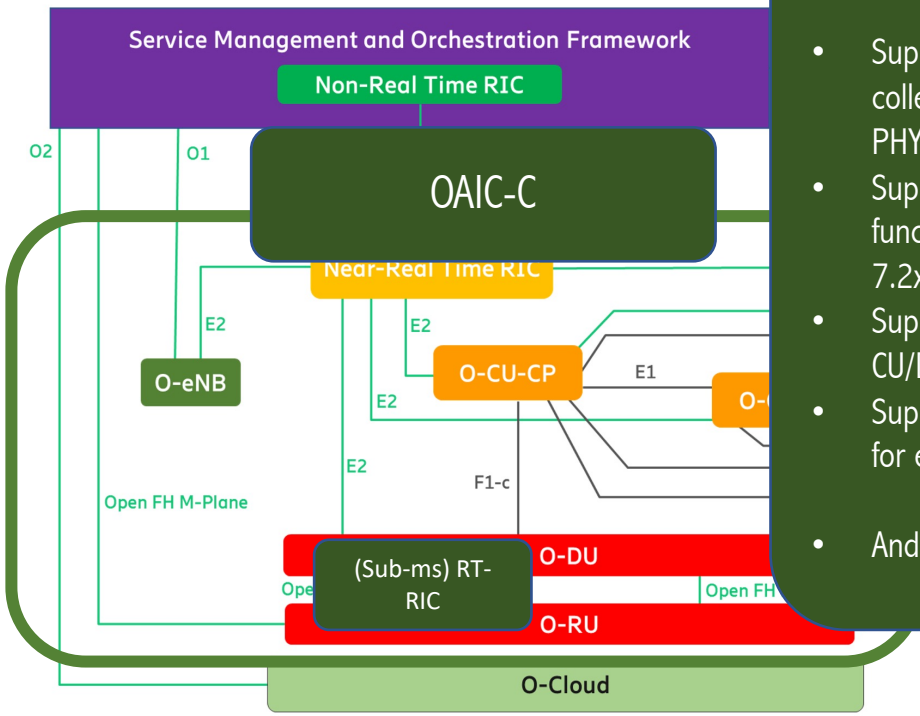
OAIC aims to develop community research infrastructure and tools that spurs **experimental research and development** on **AI-enabled cellular RANs** while leveraging **existing large-scale community research testbeds.**

Open AI Cellular (OAIC) Framework



OAIC-C

- Will be based on
  - Open-source cellular software, particularly, srsRAN NSA and SA (scheduled to be released in 2022 Q2),
  - O-RAN community software releases (Cherry and DAWN release), and
  - Software-defined Radios (SDRs), particularly USRP X310 and 410.
- Implementation on community SDR testbeds,
  - VT CORNET and
  - One PAWR platform (potentially, AERPAW)
- Focus on AI controllers for MAC and PHY



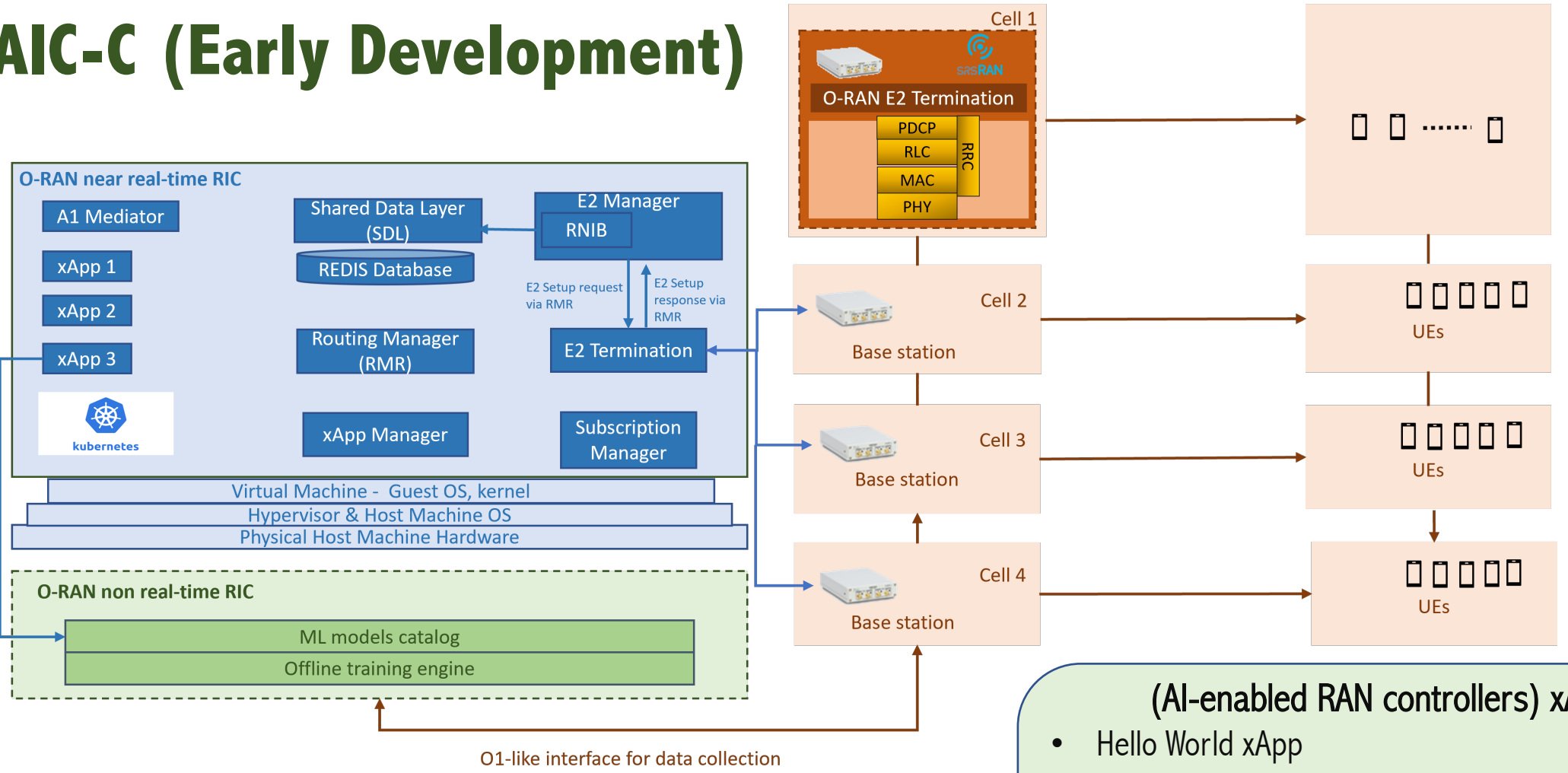
Additional R&D

- Support new data type collection required for PHY and MAC
- Support for dynamic functional split, beyond 7.2x
- Support AI/ML model in CU/DU and RU
- Support new interfaces, for example, for OAIC-T
- And …

[Reference: O-RAN Alliance, O-RAN Architecture Description 5.0 - July 2021]

VT CORNET - https://cornet.wireless.vt.edu/
AERPAW - https://aerpaw.org/
CCI 5G/Next-G Testbed - https://cyberinitiative.org/research/testbeds.html

OAIC-C (Early Development)



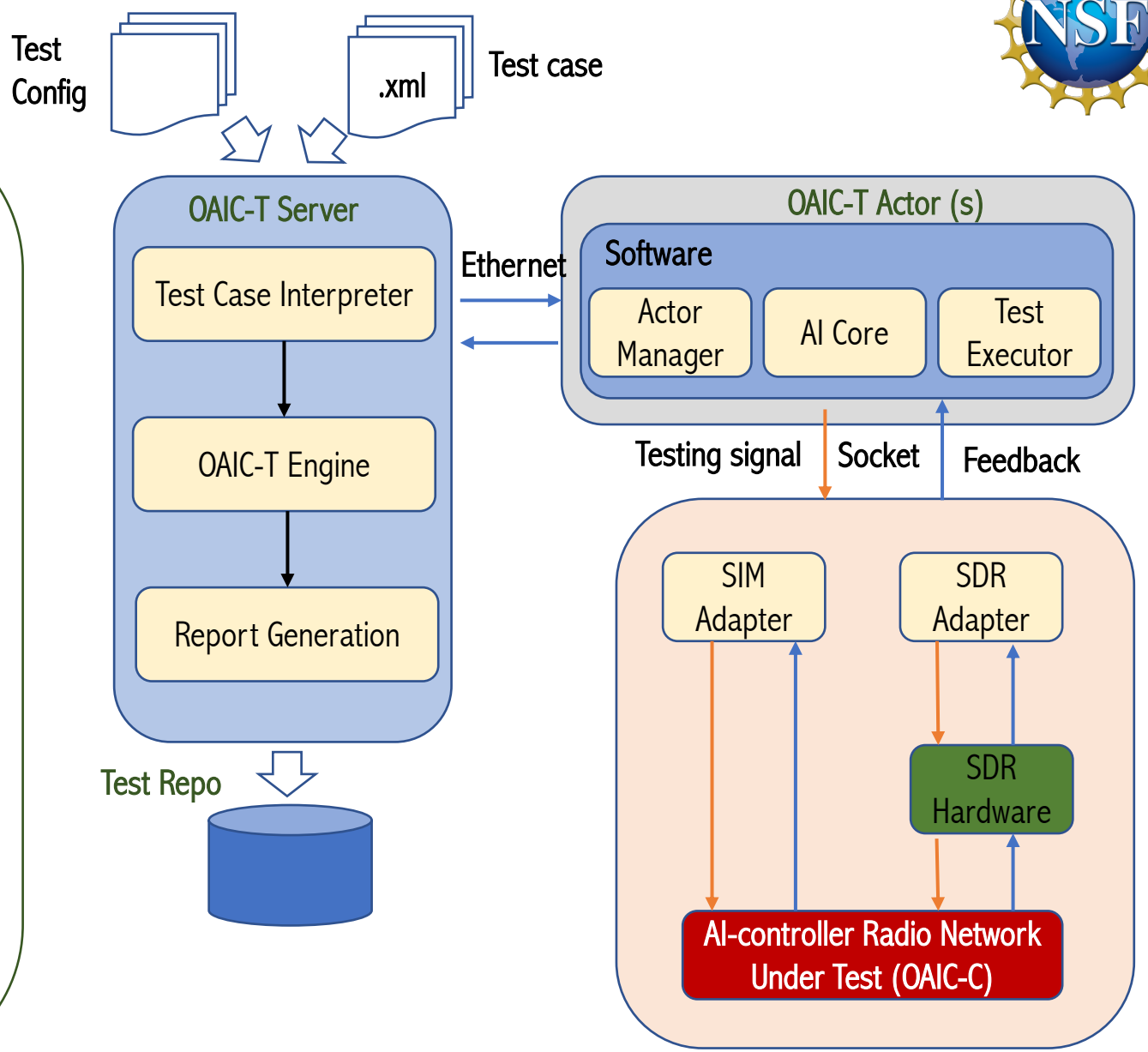
- In process of developing O-RAN compatible 5G NSA system based on srsRAN and SDRs. (Currently supports 4G/LTE system.)
  - Software: srsRAN, and O-RAN (OSC's implementation of E2 agent)
  - Hardware: B210, N300, COTS UE interfaced with a local compute node (Dell Precision 4800)

(AI-enabled RAN controllers) xApps

- Hello World xApp
- Ping Pong xApp
- KPIMON xApp
- Traffic Steering xApp
- RAN Slicing xApp (POWDER)
- **Several Scheduler xApps: OAIC** – Will be available to the research community (latest by 2022 Q1)

OAIC-T Framework

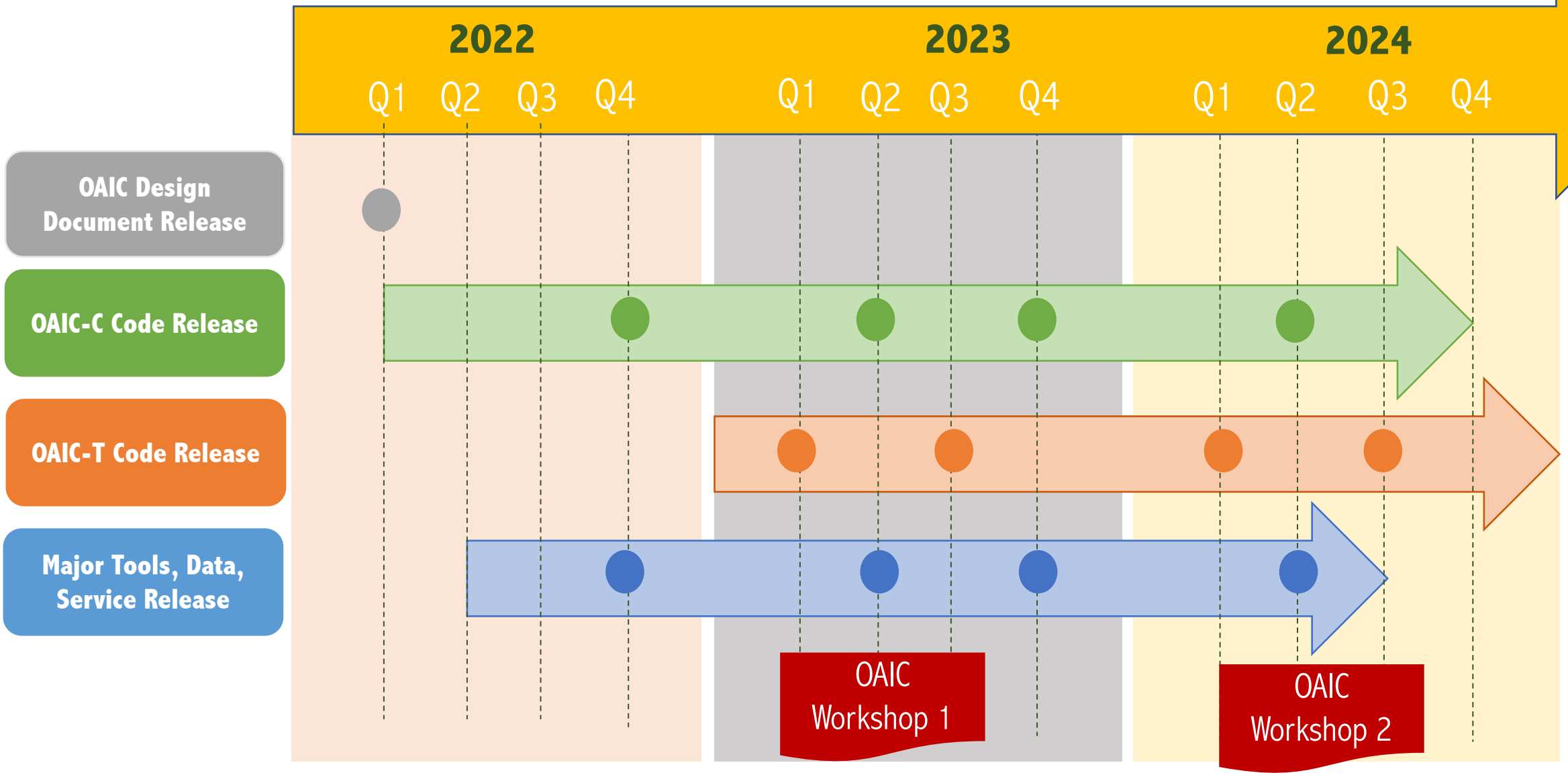
- Support **automated**, **multitasking**, and **distributed** testing.
- Leverage **AI techniques** to exhaustively and comprehensively test performance of AI-enabled controllers.
- Both modes to test OAIC-C:
  - **Simulation**
  - **SDR Hardware**



Why Do I Care?

- **OAIC (both OAIC-C and OAIC-T)** will a a **fully open-source community research infrastructure**.
  - **Source code** will be be made available via Github and/or OAIC website.
  - **OAIC SDR testbed** will be remotely accessible via website and/or terminal
- Use OAIC-C to build your **own AI controllers** (either in near-RT RIC and/or RT RIC) for PHY, MAC (and possibly higher layers) RAN functionalities.
- Use OAIC-T to test your AI-controlled RAN functionalities. (*Source code will be made available as well.*)
- All the **collected dataset** will be made available. You can utilize OAIC platform to collect your own dataset for your experimental purposes.
- All **the documentation, services, tools (and OAIC design document)** will be made available.

OAIC Timeline and Roadmap



Getting Involved?

- We want to hear your research interests, discuss collaboration opportunities, define R&D directions and joint projects.
- We seek industry involvement with building our OAIC community infrastructure, both OAIC-C and OAIC-T.

Please reach out to us if you are interested in getting involved with OAIC project

- Email: vshah22@gmu.edu (feel free to get in touch other OAIC PIs/Co-PIs.)
- Follow OAIC website for recent updates: https://sites.google.com/msstate.edu/oaic

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