Demo: Open source RAN slicing on POWDER - A top-to-bottom O-RAN use case

David Johnson
johnsond@cs.utah.edu
University of Utah
Salt Lake City, Utah, USA

Dustin Maas
dmaas@cs.utah.edu
University of Utah
Salt Lake City, Utah, USA

Jacobus Van Der Merwe
kobus@cs.utah.edu
University of Utah
Salt Lake City, Utah, USA

ABSTRACT

This demonstration will showcase our efforts to develop a radio access network (RAN) slicing mechanism that is controllable via management software in an Open RAN framework. To our knowledge, our work represents the *first effort* that combines an open source Open RAN framework with an open source mobility stack, provides a top-to-bottom RAN application via the RAN intelligent control (RIC) provided by that framework and illustrates its functionality in a realistic wireless environment. Our software is publicly available and we provide a profile in the POWDER platform to enable others to replicate and build on our work.

CCS CONCEPTS

• **Networks → Programmable networks**.

KEYWORDS

open RAN, RAN slicing, programmability

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1 INTRODUCTION

The "softwarization" of network functionality, (software-defined networking, network function virtualization, network programmability, network virtualization), that has fundamentally changed networking over the last decade is now also being applied to mobile networks in general and the radio access network (RAN) in particular. Specifically, the "Open RAN" concept has evolved from early research prototypes [8] to consortia with broad industry participation [9] and has also attracted interest from regulators [1]. The inherent complexity of the RAN ecosystem, coupled with the fact that RAN functionality by itself is rapidly evolving, suggests Open RAN as a broad emerging research area, with open issues in applicable use cases, spectrum management, systems realization, security etc.

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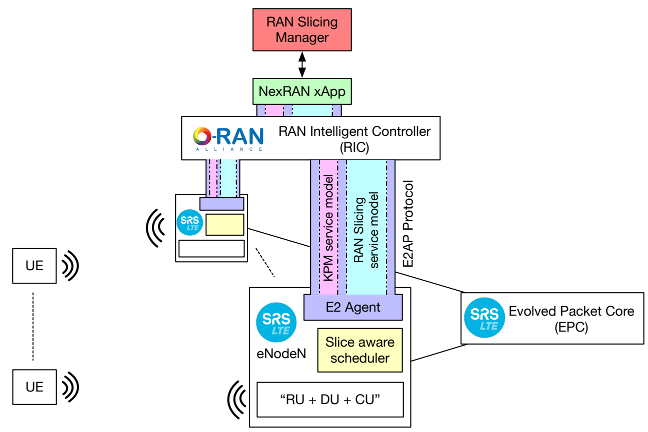

Figure 1: Open RAN open source RAN slicing

This same inherent complexity, however, hampers research efforts in this area. First there is a lack of open source frameworks to bootstrap research efforts in this space. It is true that, for example, the O-RAN Alliance provides open source software via the O-RAN Software Community [9]. These code bases provide the O-RAN "control stack" but do not themselves provide the necessary O-RAN support for existing RAN implementations (e.g., an O-RAN-enabled eNodeB/gNodeB). Second, and related, the example use cases that are currently available within these open source frameworks are still under development (e.g., traffic steering, admission control, etc), or are limited in functionality (e.g., RAN metrics collection). As a result it is difficult for practitioners to develop an understanding of the full end-to-end functionality enabled by an open RAN approach. Third, while there is general agreement about the potential of an open RAN approach, developing use cases that could truly advance the state-of-the-art, requires exploration and testing in realistic wireless environments to explore and validate the feasibility of the open RAN architecture and the applications it enables.

In this demonstration we will showcase our efforts to address these shortcomings. We have:

(i) Combined the popular srsLTE (now srsRAN [11]) open source mobile networking stack with the open source RAN intelligent controller (RIC) provided by the O-RAN Software Community [9],
(ii) Developed a top-to-bottom use case, involving RAN slicing in this framework, and

(iii) Packaged this as a profile on the POWDER mobile and wireless testbed [7] as an artifact to enable open RAN research in a realistic wireless environment.

2 OVERVIEW

Figure 1 provides an overview of the Open RAN framework we have realized by combining software from the O-RAN Software Community and srsLTE. The figure also shows the specifics of our implementation efforts that will be showcased in the demonstration and which we describe in more detail below.

For the demonstration we will instantiate a version of the framework depicted in Figure 1 using equipment in the POWDER platform [7]. POWDER is an end-to-end platform for research on mobile wireless networks. It provides radios that are programmable down to the waveform, attached to a network that can be configured by the user, connected to a wide variety of compute, storage, and cloud resources.

Our demonstration will show the O-RAN RAN slicing use case in an over-the-air configuration on POWDER. Specifically, for this demo, UEs will be common-off-the-shelf (COTS) UEs or UEs realized with software-defined-radios (SDRs) and small form factor compute nodes, eNodeBs will be realized with SDRs and compute nodes in an edge compute cluster, and the evolved packet core (EPC) will run on general purpose compute nodes. *The POWDER platform is completely remotely accessible.* As such the demo will not require any special arrangements and will simply make use of the screen sharing functionality of virtual conferencing software. More importantly, that also implies that POWDER platform users can access the demonstrated functionality remotely.

3 DEMO DESCRIPTION

The demo involves RAN slicing using the O-RAN reference near-realtime RIC platform, a custom xApp and service model, and modified srsLTE software.

In particular, we have enhanced the srsLTE software to realize a slice-aware scheduler and have added an O-RAN E2 agent to srsLTE. As shown in Figure 1, E2 is a north-bound interface that connects the RIC with underlying radio equipment, such as eNodeBs and gNodeBs. The E2 agent implements the core E2 Application Protocol (E2AP) and has access to the internal RAN components in the eNodeB's stack to monitor and modify RAN parameters.

O-RAN service models are realized within the context of the E2AP protocol and expose various RAN related functionalities to the RIC and the xApps hosted by the RIC. xApps in turn realize the logic associated with managing or manipulating such RAN functionality. Our E2 agent provides an implementation of the standard O-RAN key performance measurements (KPM) service model [10] to provide key performance metrics. As shown in Figure 1, we have also implemented a custom 3GPP-like service model to expose our RAN slicing implementation as a set of abstractions and controls to xApps executing on the RIC. We also developed a custom xApp (NexRAN) in c++, using some of the xApp and RIC message router (RMR) framework libraries, that implements/consumes both the KPM service model and the RAN slicing service model. NexRAN exposes this functionality, via a RESTful API, to a RAN slicing manager. The slice manager can create slices, bind/unbind them to multiple eNodeBs, bind/unbind UEs to those slices, and dynamically modify slice resource allocations.

We provide a POWDER profile that automatically deploys the O-RAN reference RIC on servers within the POWDER testbed, and preinstalls and configures the demo environment. Note that this means readers can run this demo themselves, by obtaining a POWDER account [12] and then instantiating an experiment with the O-RAN RAN slicing profile [3].

All software associated with our efforts are publicly available:

(i) O-RAN RAN slicing POWDER profile [3], a POWDER specification that specifies the hardware and software resources needed to automatically instantiate the setup described in this writeup,
(ii) srsLTE with O-RAN E2 and slice aware scheduler [6], i.e., a fork of the srsLTE code base with our enhancements,
(iii) NexRAN xApp [2], the xApp that interacts with both the KPM and RAN slicing service models
(iv) POWDER fork of e2 core repo with minor bugfixes [4],
(v) POWDER fork of kpimon xApp with bugfixes [5].

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REFERENCES

[1] 2021. FCC Seeks Comment on Open Radio Access Networks. https://www.fcc.gov/document/fcc-seeks-comment-open-radio-access-networks-0.
[2] 2021. NexRAN xApp. https://gitlab.flux.utah.edu/powderrenewpublic/nexran/.
[3] 2021. O-RAN RAN slicing. https://www.powderwireless.net/p/PowderProfiles/O-RAN.
[4] 2021. POWDER fork of e2 core repo with minor bugfixes. https://gitlab.flux.utah.edu/powderrenewpublic/e2.
[5] 2021. POWDER fork of kpimon xApp with bugfixes. https://gitlab.flux.utah.edu/powderrenewpublic/ric-scp-kpimon.
[6] 2021. srsLTE with O-RAN E2. https://gitlab.flux.utah.edu/powderrenewpublic/srslte-ric/.
[7] Joe Breen, Eric Eide, Earl Lewis, Daniel Reading, Andrew Buffmire, Mike Hibler, Dustin Maas, Robert Ricci, Jonathon Duerig, David Johnson, Alex Orange, David Schurig, Kevin Dutt, Sneha Kumar Kasera, Neal Patwari, Leigh B. Stoller, Jacobus Van der Merwe, Kirk Webb, and Gary Wong. 2020. Powder: Platform for Open Wireless Data-driven Experimental Research. In *ACM WiNTECH proceedings*. https://doi.org/10.1145/3411276.3412204
[8] Xenofon Foukas, Navid Nikaein, Mohamed M. Kassem, Mahesh K. Marina, and Kimon Kontovasilis. 2016. FlexRAN: A Flexible and Programmable Platform for Software-Defined Radio Access Networks. In *Proceedings of the 12th International on Conference on Emerging Networking EXperiments and Technologies (CoNEXT '16)*. ACM, New York, NY, USA, 427–441. https://doi.org/10.1145/2999572.2999599
[9] O-RAN Alliance. 2020. O-RAN Software Community. https://www.o-ran.org/software
[10] O-RAN Alliance. 2020. O-RAN Working Group 3: Near-Real-time RAN Intelligent Controller - E2 Service Model (E2SM). ORAN-WG3.E2SM-KPM-v01.00.00.
[11] Software Radio Systems. [n.d.]. srsRAN is a 4G/5G software radio suite developed by SRS. https://github.com/srsran/srsran.
[12] The POWDER Team. 2018. Powder (the Platform for Open Wireless Data-driven Experimental Research). https://www.powderwireless.net.