On Deploying a Campus Scale Private 5G Open RAN Testbed

Andrew E. Ferguson, Ujjwal Pawar, Tianxin Wang and Mahesh K. Marina
The University of Edinburgh

Mobile networks in the recent past have embraced *disaggregation* at different levels, driven by the need for cost-effective and flexible system architecture that accelerates innovation and enables new services. Complimentarily, they are increasingly leaning towards *data-driven and AI powered operation* to unlock significant energy, operational and spectral efficiency gains. These trends are most prominently evident in the *Open Radio Access Network (RAN) architecture*, being standardized by the O-RAN Alliance, comprised of disaggregated RAN components with open standardized interfaces between them, and RAN Intelligent Controllers (RICs) and Apps to intelligently drive RAN operations [1].

While Open RAN is expected to become an integral part of next generation mobile network system architecture in general, *private 5G mobile networks* [2] in particular are seen as the early adopters. Unlike national scale public mobile networks, private networks are local scale deployments that are attractive for industrial (e.g., manufacturing, mining, warehouses) and enterprise (e.g., business parks, universities, hospitals) settings, transport hubs, venues and such. This is because they not only allow high degree of control and customization but also offer greater opportunity for innovation (e.g., sensing applications that leverage the mobile network communication infrastructure).

University campuses are a representative and compelling setting for Open RAN based private 5G networks. Moreover, as history has shown with software-defined networking (SDN), campus networks can be excellent experimentation grounds for innovative technological solutions and services that have the potential to shape our future connectivity [3].

With the above motivation, we have recently deployed the first of its kind campus-wide, O-RAN-compliant private 5G testbed across the central campus (over 50 acres) of the University of Edinburgh. At a physical level, this deployment consists of twenty radios (RUs in O-RAN parlance) from two different vendors installed on rooftops of different campus buildings, all operating in the 3.8-4.2 GHz shared access spectrum. The maximum possible power level (medium or low) and antenna type (omni or directional) for each radio was carefully chosen not only to yield blanket coverage across campus but also to ensure adequate capacity to provide cutting-edge data rates in high footfall areas on the campus.

In line with the Open RAN architecture, bulk of the RAN processing for the network operation is consolidated in an edge cloud powered by a set of telco-grade servers. The edge cloud is deployed in one of the campus buildings and is connected to each of the RUs through a high-speed network switch and custom fibre. Additional servers for management, GPU based AI compute and storage are integrated into the edge cloud to ease management and enable the deployment of data-driven "Apps" for network monitoring, control and beyond. All the testbed components are synchronized with a PTP grandmaster clock to ensure reliable and performant operation.

Noting that most functionality in a modern 5G network resides in software in the form of various virtualized net-

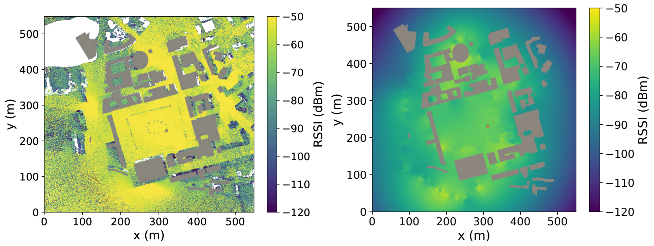

Figure 1: (a) Ray-tracing-based coverage map, (b) Measurement-based coverage map.

work functions, we have deliberately aimed to keep our testbed highly flexible with several alternative software options. These include multiple different RAN software stacks (e.g., srsRAN, OpenAirInterface) and RIC platforms (Janus, EdgeRIC, FlexRAN, O-RAN SC). We have also integrated various data-driven Apps for RAN and beyond into the testbed, including apps for RAN telemetry data collection, anomaly and interference detection, power saving and device localization.

We have assessed the radio signal coverage from the testbed before and after deployment through Received Signal Strength Indicators (RSSI) based coverage maps in 2D at 1m$\times$1m bin granularity. At the planning (pre-deployment) stage, we constructed a real-world scene model of our campus and used SionnaRT [4] to generate a ray tracing (RT) based coverage map. This estimated coverage map reflects the highest RSSI values at each bin. Post deployment, we constructed a measurement-based coverage map. For this, we first collected field measurements of RSSI along a walking route. Then spatial interpolation is applied across the entire target area using radial basis function (RBF) interpolation, with multiquadric functions as the basis, to obtain the coverage map. As shown in Figure 1, both estimated and measured maps reflect blanket coverage across the campus area, with particularly strong coverage in the central George Square area.

References

[1] M. Wani et al. Open RAN: A Concise Overview. *IEEE Open Journal of the Communications Society*, 6:13–28, 2025.

[2] L. Peterson, O. Sunay, and B. Davie. *Private 5G: A Systems Approach*. 2023.

[3] N. McKeown et al. OpenFlow: Enabling Innovation in Campus Networks. *ACM SIGCOMM Computer Communication Review*, 38(2):69–74, March 2008.

[4] J. Hoydis et al. Sionna RT: Differentiable Ray Tracing for Radio Propagation Modeling. *arXiv preprint arXiv:2303.11103*, 2023.