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Demonstration of Joint SDR/UAV Experiment Development in AERPAW

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***Abstract*—The Aerial Experimentation and Research Platform for Advanced Wireless (AERPAW) is an outdoor testbed providing the experimenters access to programmable radios and programmable vehicles. A key aspect of AERPAW is its experiment development environment. This demo introduces potential users to the main capabilities of AERPAW's development environment. The demo exercises the main three flexible testbed capabilities, namely the ability of an experimenter to choose a wireless radio setup, a vehicle setup, and to set up traffic. The experiment is then executed live, and the collected data is post-processed and displayed.**

I. Introduction

The Aerial Experimentation and Research Platform for Advanced Wireless (AERPAW) [1] is one of the four NSF sponsored Platforms for Advanced Wireless Research (PAWR). Each of the four PAWR testbeds have their unique characteristics; for AERPAW, the main distinguishing characteristic is the availability of programmable Unmanned Aerial Vehicles (UAVs) and Unmanned Ground Vehicles (UGVs). Therefore, in AERPAW, the two main types of nodes available for experiments are fixed nodes (installed on towers in the field and rooftops on campus), and portable nodes, which are carried by (and which control) the testbed vehicles (UAVs and UGVs). Fig. 1 shows two large AERPAW multicopters on our main flying field.

In AERPAW, the UAVs and UGVs are under the direct control of the experimenters, who have complete control (within a set of safety constraints) over the trajectory of the vehicles. For practicality (and safety), the experimenters do not develop their experiments directly on the portable and fixed nodes available in the outdoor testbed, but rather in a separate development environment, that is setup as a *digital twin* of the physical testbed environment. In the development environment, the vehicles and wireless propagation are being emulated, while the rest of the software is kept unchanged as an experiment transitions between the development and the testbed modes.

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Fig. 1. Coordinated takeoff of two large AERPAW multicopters.

II. Demo of AERPAW's Development Environment

The main goal of the demonstration it to familiarize the audience with the main ways of setting up an experiment in AERPAW's development mode, execute the experiment in development mode, and retrieve the results of the experiment.

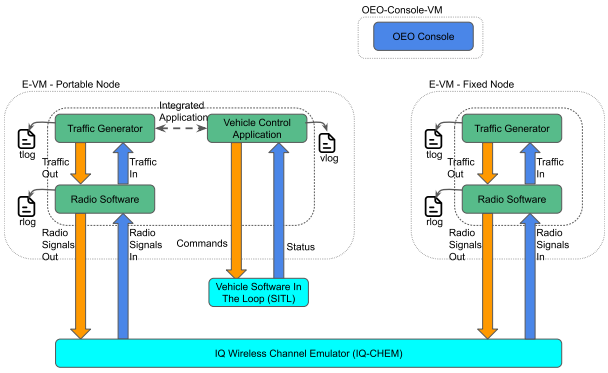

Fig. 2. Overview of AERPAW's development environment with the OEO console, and a UAV with a portable node and a fixed node exchanging radio samples over the wireless channel emulator.

The demonstration starts with a very brief introduction of the AERPAW platform and its capabilities, as

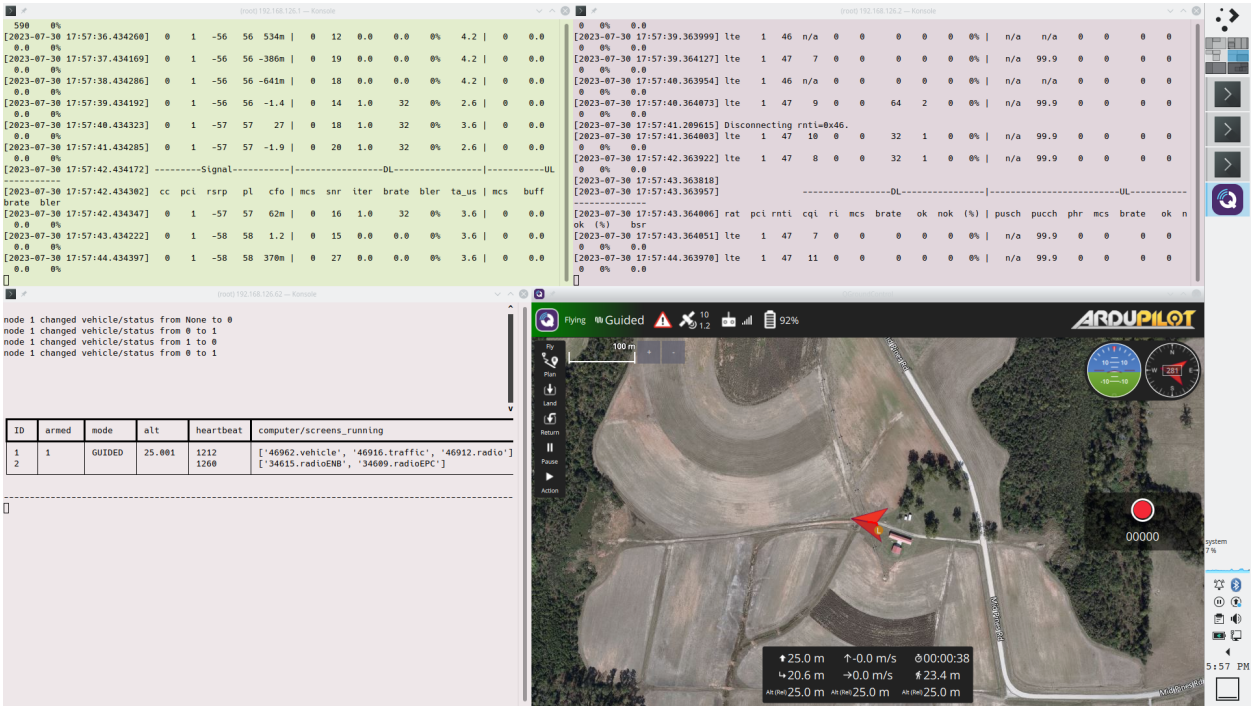

Fig. 3. Screenshot of an ongoing experiment with the ground control station shown in the lower right corner, the OEO console in the lower left, then the portable node radio screen (srsRAN UE) in the upper left terminal, and the fixed node radio script (srsRAN eNB) in the upper right terminal.

well as the different ways of obtaining service from the platform, with an emphasis on the canonical experiments, which are the focus of the rest of the presentation. Emphasis is put on showcasing the differences between development mode and testbed mode, as well as the fact that in our canonical mode of operation, the execution of the software is in batch mode.

As the first steps, an experimenter account is created at the AERPAW portal, and then a project and a new experiment are created. In an attempt to strike a balance between an interesting and a compelling experiment, we showcase an experiment featuring one fixed node and one portable node on an UAV, as depicted in Fig. 2.

The demonstration shows how experimenters can gain access to the development environment, by opening a couple of terminals to the fixed and portable nodes in the experiment, as well as to the Operator Experiment Oversight (OEO) console. Finally, QGroundControl, a popular ground control station, is used as a graphical interface, allowing the experimenters to visualize the movement of the UAV during the experiment.

In AERPAW, in order to increase flexibility there is a separation between the *vehicle script* (which controls the movement of the vehicle), the *radio script* (which controls the first two layers of the radios), and the *traffic script* (which controls the upper layer traffic). For this demonstration, we use a predetermined trajectory script for the vehicle, an srsLTE eNB on the fixed node, and a UE on the portable node as radio scripts, and ping as the traffic generator. We present the major options for each type of script.

Once the setup is complete, the experiment is started from the OEO Console, and its progress is monitored by watching the graphical user interface. Fig. 3 shows a sample screenshot during the experiment execution.

After the experiment is concluded, the results of the experiment are shown, and the demonstration concludes after post-processing the results from the experiment executed in the development environment, with a brief discussion of how the experiment is transferred to the testbed, and how the results are retrieved in a real experiment.

References

[1] "AERPAW - Aerial Experimentation and Research Platform for Advanced Wireless." https://aerpaw.org.