A new mobile passive radar designed for transmitters up to 1.5 GHz for detection of aerospace and geoscience targets

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Passive radar permits inexpensive and stealthy detection and tracking of aerospace and geoscience targets. Transmitters of opportunity such as commercial FM broadcast, DTV broadcast, and cell phone towers are already illuminating many populated areas with continuous power. Passive radar receivers can be located at a distance from the transmitter, and can sense this direct transmission as well as any reflections from ground clutter, aircraft, ionospheric turbulence and meteoroids. The 100% duty cycle allows for long coherent integration, increasing the sensitivity of these instruments greatly. Presented here is a new passive radar receiver designed to analyze any transmission of opportunity with frequencies up to 1.5 GHz without the use of a front end analog downconverter. The receiver centers around a Reconfigurable Open Architecture Computing Hardware (ROACH) board developed by the Collaboration for Astronomy Signal Processing and Electronics Research (CASPER) group. The radar is designed for mobile operation. It fits within a 19" rack, it is equipped with solid state hard drives, and can run off an uninterruptible power supply (UPS) for up to 1 hour of continuous operation. In this paper we describe technical details of the hardware, firmware, and software of the system including the use of polyphase filtering in lieu of traditional digital downconversion. We describe the use of the cross-ambiguity function as a detection mechanism. We present preliminary results of detections from this radar. In stationary operation, the same helicopter has been detected using two different DTV transmissions. We present early results of mobile operation, in which the doppler-spread ground clutter and possible detection of aircraft can be seen, again with the use of DTV broadcast. Finally, we detail future developments to exploit the full capabilities of this versatile new system.