An Update on the “Horus” All-Digital Polarimetric Phased Array Weather Radar

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Sampling of existing mechanically scanning radars is insufficient to capture the four-dimensional evolution of atmospheric dynamics and microphysics. The scientific community has shown intense interest in the development of rapid-scanning polarimetric radars to address these needs and strongly desires community-wide access to the necessary phased array radar technology. In order to meet the desired update times and polarimetric quality, it is expected that a fully digital phased array architecture will be necessary. The Advanced Radar Research Center (ARRC) at the University of Oklahoma (OU) is working with NOAA’s National Severe Storms Laboratory (NSSL) on the development of a digital-at-every-element, S-band, dual-pol phased array radar. The mobile radar (shown in the figure) is called “Horus” after the Egyptian god of war and sky. With an aperture of approximately 1.63 m, the Horus radar will have 1024 (32x32) dual-pol channels and will be capable of extreme flexibility in terms array segmentation, channel-independent waveforms, adaptive beamforming, etc. Each channel will produce more than 10 W of peak power and will support a duty cycle of 10%, thus providing a sensitivity of approximately 12.5 dBZ at 50 km. Though its limited size means that the S-band Horus radar does not provide the angular resolution typically expected from a weather radar, it is extremely scalable and will serve as an engineering testbed for next-generation weather radars. Given the importance of radar polarimetry to the weather community, its most-important feature will be the capability of performing real-time and frequent array and polarimetric adaptive calibration as a routine part of the Horus scanning strategy. By exploiting mutual coupling between individual radiating elements that make up the array and the waveform independence of an all-digital array, the ARRC is currently developing automatic algorithms for array/polarimetric calibration. The system will be based on a slat/brick design for the majority of the electronics; hence, the electronic modules will be line replaceable for simplification of routine maintenance. These electronics include the RF front-ends, commercial-off-the-shelf (COTS) transceivers, and on-board FPGA processing. This functionality will be combined into a single so-called “Octoblade” composed of 16 highly compact and functional channels. The Octoblade will also include liquid cooling. The dual-polarization patch antenna has extremely high polarimetric isolation (better than -40 dB), which is enhanced further by the design of the RF channels. Although the system is extremely flexible, if desired to reduce data size, partial systolic beamforming will be possible with the on-board FPGAs. Data transfer will be handled with a high-speed RapidIO network. The overall system concept and rationale for various design decisions will be presented along with the current status of the project and future plans.

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