8.5 AN ALL-DIGITAL POLARIMETRIC PHASED ARRAY RADAR FOR COMBINED WEATHER AND AIRCRAFT SURVEILLANCE

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Currently, radars for weather observation and aircraft surveillance are specifically designed for their missions and, therefore, have quite different architectures. Modern weather radars are dual-polarization, use mechanically scanned dish antennas with pencils beams, and provide volumetric coverage with update times on the order of a few minutes. Aircraft surveillance radars are usually not dual-polarization and use a fan beam with a rapidly spinning positioner. Although high-fidelity height information is normally not provided, aircraft azimuth positions are updated every few seconds. If these two distinct mission requirements could be met with a single radar, significant reduction in lifecycle costs could be realized. The challenge is to design such a multi-mission radar at reasonable cost while continuing to provide high-quality weather observations and air traffic management capabilities. The Advanced Radar Research Center (ARRC) at the University of Oklahoma (OU) in the USA is working with NOAA's National Severe Storms Laboratory (NSSL) on this concept, which will likely leverage phased array radar technology. This goal has presented many challenges, especially regarding meeting mission requirements within the desired update time and the necessity of combining high-quality polarimetry with phased arrays. Many of these challenges can be met with a fully digital polarimetric phased array radar. The so-called Horus project is currently being undertaken by the ARRC and NSSL and will result in an all-digital, S-band, polarimetric phased array radar. The Horus radar will have 1024 dual-pol channels and will be capable of extreme flexibility in terms array segmentation, channel-independent waveforms, adaptive beamforming, etc. Given the importance of radar polarimetry to the weather community, its most-important feature will be the capability of performing real-time and frequent 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. Finally, the all-digital design of the Horus radar will serve as an ideal testbed for evaluation of the level of digitization (e.g., subarrays versus all-digital) needed to meet multi-mission requirements. The system will be based on a slat/brick design for the majority of the electronics including 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 and will be line replaceable for simplification of routine maintenance. The dual-polarization 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.