National Weather Radar Testbed System

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The National Weather Radar Testbed (NWRT) is a real-time digital signal processor for weather radar research. The NWRT System is being implemented by the Lockheed Martin Corporation at their Moorestown New Jersey Facility. The NWRT system is based on the SPY-1 radar, a phased array radar originally used onboard US NAVY AEGIS warships. In this incarnation, it has been adapted for use as a weather research radar. The radar data is processed by a subsystem called the Environmental Processor(EP). The EP converts the raw radar data into spectral moment products, or estimates of the reflectivity (i.e. measure of rain intensity), radial velocity, and spectrum width (an indicator of wind sheer and turbulence). The EP calculates these products using a variety of methods including Pulse Doppler processing and Pulse-pairs processing (a phase difference method of velocity estimation). The requirements of the NWRT system using phased array radar data at rates up to 10 Msamples/sec required a processing architecture that could perform the Pulse Doppler and Pulse Pairs algorithms in real-time. The pulse Doppler processing specifically requires several thousands of 16 or 32 point FFTs to be computed, requiring the EP to have parallel processing capability (i.e., each processor handles a single radar dwell, with 20 processor running in parallel). In addition, the EP performs the matched filtering function (in the frequency domain using FFTs), clutter filtering (in the time domain), and generation of the output data file, called the Universal Format (UF) file, all in real-time along with the spectral moment processing. All of the signal processing algorithms in the EP were written using the standard Vector, Signal and Image Processing Library (VSIPL).

The EP was initially sized to perform real-time data processing including pulse compression (i.e., matched filtering) and clutter filtering on two frequency channels of I/Q data using a 32 pulse Doppler processing mode on data at 10 MSamples/sec. The system as delivered should exceed the expected performance as specified during the initial EP design phase.

The EP is implemented using five SKYbolt II 6U VME multiprocessor boards from Sky Computers Inc, of Chelmsford MA. Each SKYbolt has four 500 MHz PowerPC 7410 processors and 1 Gbyte of memory. The processors communicate using shared memory and the SKYchannel 320 Mbyte/sec packet bus. One processor acts as a front end controller and parcels out radar data to the others for processing. In most cases, an entire "thread" of pulses is processed by one processor. The EP is interfaced to the radar receiver using a fiber interface running at 80 Mbytes/sec. The EP also includes a high speed RAID system to record radar data as it is acquired. The RAID system allows previously recorded data to be played back to the processing system in real time to test new algorithms.