Investigation of a RF sampling (all-digital) method for the TIGER radar receiver

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RF sampling provides a fully digital implementation, with the exception of an analogue input Band Pass filter and pre-amplifier. For this a relatively simple Butterworth Band Pass filter and off the shelf wideband (2GHz) low noise pre-amplifier can be used. These analogue components produce little phase shift, resulting in an antenna/receiver combination for all (16/20) channels that is easy to build, align and install. The method is technically demanding on the analogue to digital converter (ADC), as both very high speed and large dynamic range is required. Presently available high speed ADCs do not come with enough bits to meet the full dynamic range requirements of the receiver. Current ADC devices, although expensive, can be used with digitally controlled pre-amp gain settings. This technique is the equivalent of that used in the current SuperDARN system. Its use would sacrifice some of the advantages of a simple analogue front end – which is the long-term goal. An option on the way to achieving our ultimate goal of a fully digital receiver is to use digitally controlled pre-amp gain setting until higher bit ADCs become available (in approximately three years – Moore's law). RF sampling also places a heavy demand on the digital technology. A large number of high-speed digital signal processing (DSP) calculations are required. Large-scale FPGA devices are now becoming adequate for this task. The use of special DSP techniques such as, Polyphase filters and CIC (cascaded integrator-comb) will be necessary to achieve a feasible RF sampling implementation of the digital TIGER radar receiver.