Development and Deployment of an X-band Reflect-Array Radar

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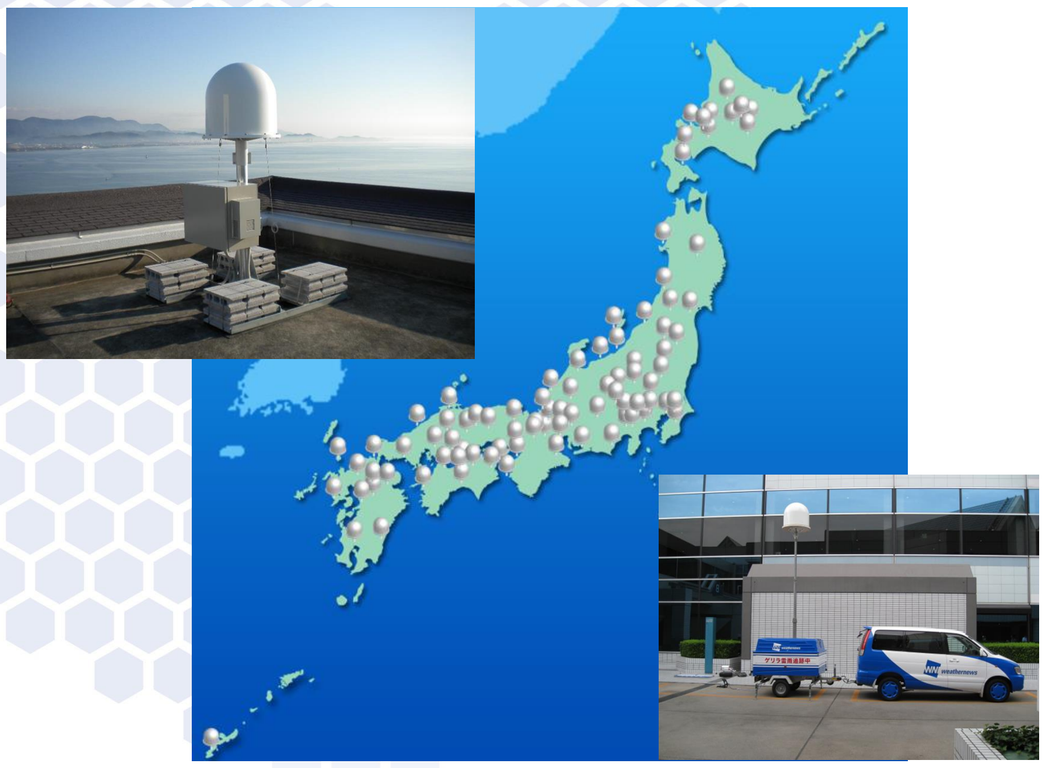
Background

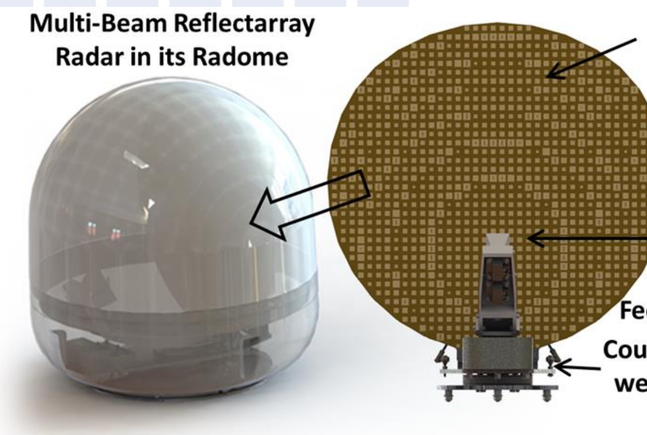
The Weathernews Inc. (WNI) has been operating an adaptive, X-band, weather radar network in Japan since 2010, now with nearly eighty radars making up the network. The first radar design, referred to as the "WITH Radar", is an integration of a commercial airborne weather radar, signal-processing unit, and pedestal with the goal of minimizing both initial and maintenance costs.
Since 2013, WNI and the University of Oklahoma (OU) have been collaborating on the development of a custom, low-cost, portable X-band weather radar. Using a unique dual-feed reflect-array design, the radar can observe two elevation angles simultaneously doubling the temporal resolution for a volume scan time.



WITH radar has already been installed and operated at up to 80 locations in Japan.

Specification

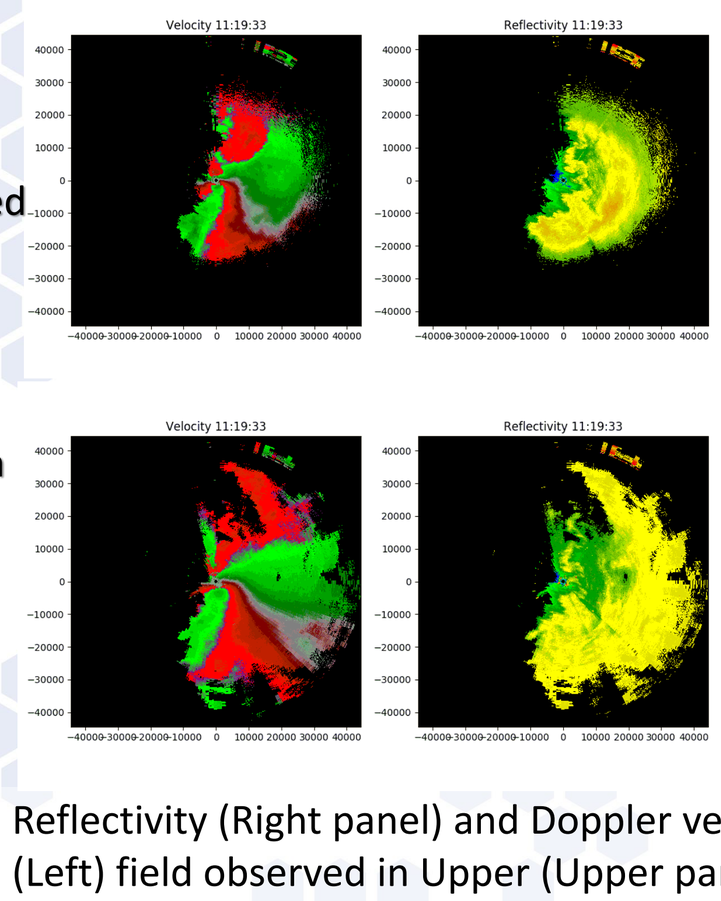
This radar, referred to as the EAGLE, Enthusiasm for Asia-Genesis Leading Edge, Radar, has a capability of super-rapid scanning function in order to detect rapid-developing thunderstorms. That function is effective for supporting our customers such as road maintenance companies and individual consumers, because they are concerning about the heavy rainfall. Another important factor of the radar is “low-cost”. WNI is planning to deploy at least fifty radars into the Asian countries and regions, at first. To support customers in Asia the low-cost infrastructure of weather radar and surface observation instruments is needed. Only the horizontal polarization is applied to reduce the cost, but owing to the low-cost, a lot of radars can install closely and recover one of the big disadvantages of X-band radar; the rain attenuation.



Outlook of the EAGLE radar (Courtesy of Dr Fulton)

Initial Results

We have started our testbed in Norman, OK, and still continue to upgrade this radar. The distributions of the reflectivity and the Doppler velocity have been updated according to the passage of the storm with enough sensitivity.

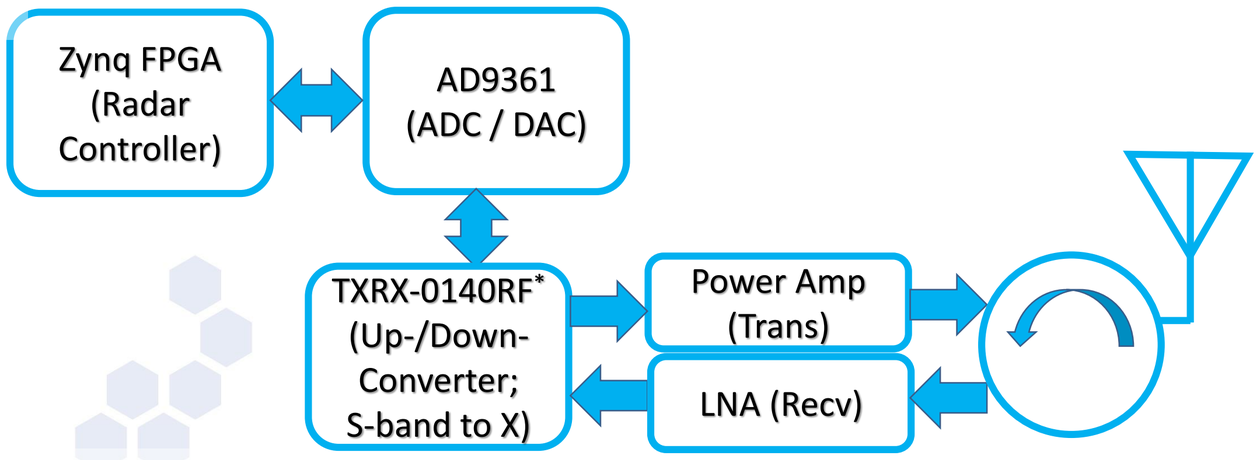


Reflectivity (Right panel) and Doppler velocity (Left) field observed in Upper (Upper panel) and Lower beams, respectively on May 19, 2017

Specifications	
Operating Frequency	9410 – 9450 MHz
Pulse Width	1 to 100 us
Range Resolution	Down to 30 m
Pulse Repetition Frequency	100 to 200 Hz
Sensitivity	30 dBZ @30 km
Antenna Type	0.6m microstrip patch reflect-array, with two feeds, two mechanical Elevation tilt positions
Polarization	Horizontal
Gain	32 dBi (Lower beam) / 31 dBi (Upper beam)
3dB Beamwidth	3.9° (Lower) / 4.2° (Upper)
Scanning Speed	Up to 12 RPM
RF Transmitter	Solid State
Peak Power	150 W
Signal Processor	12bit ADC/DAC, 15Msps
Sampling Gate Spacing	10m

Future Plan

We still have some developments to have the functionality of the elevation angle changing up to 20 degree and the code-modulation capability to prevent the interference. The interference between our radars and between ours and operational radars should be reduced, because of the frequency allocation.
As mentioned above, We have a plan to deploy fifty radars in Asia and one hundred in Japan, starting from 2019.



Simplified block diagram of the EAGLE radar *Developed by ARRC, OU

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The UNIVERSITY of OKLAHOMA Advanced Radar Research Center