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Origin and Nature of Electromagnetic Interference in X-band Weather Radars

Mattia Vaccarono* [1,2], V. Chandrasekar [2], Renzo Bechini[2,3], Roberto Cremonini[3]
(1) Arpa Piemonte, Dipartimento Rischi Fisici e Tecnologici, Via Jervis 30, Ivrea, mattia.vaccaronor@arpa.piemonte.it
(2) Colorado State University, Fort Collins, USA, mattia.vaccarono@colostate.edu
(3) Arpa Piemonte, Dipartimento Rischi naturali e Ambientali, Via Pio VII 9, Torino

Weather radars are experiencing an increasing amount of strong interferences caused by artificial radio sources, such as telecommunications systems, with a negative impact on radar quantitative measurements. In most European countries, operational weather radars operate at the C-band, in the 5.6 GHz frequency band, which is shared with Radio Local Area Networks (RLAN) and Wireless Local Area Networks. The impact of these telecommunications systems in weather radar measurements has been already discussed in literature.

In this work, we focus on the X-band weather radar managed by Arpa Piemonte, the environmental agency of Piemonte region, Northwestern Italy. This radar, deployed for research purposes, is currently located near Vercelli city and it has shown a continuous increase of radio interferences since 2014. At X-band no civil communications are allowed, then it is likely that electromagnetic interferences may be caused by out-of-band or spurious emissions.

The analysis of clear air radar observations shows a daily pattern, with interferences detected mostly between 7am and midnight, local time. Comparing the locations of the mobile base stations available in the regional database of electromagnetic sources and the radial directions of the interferences, it is likely that the electromagnetic interferences are caused by mobile telecommunication transmitting towers. Those base stations do not operate the 1.8 GHz 4G systems from midnight to 6am to reduce power consumption unless the other 4G carriers, such as 0.8GHz and 2.6GHz, cannot handle the mobile communications in their coverage area.

Time series of IQ data have been specifically acquired with the X-band radar in order to gain more insight on the characteristics of the interfering signals. The signals polarization is elliptical along the -45° slope line. This polarization, widely used in mobile communications, is related to linearly polarized signal reflected by the environmental surfaces during its path to the radar. The signals analysis shows a circular modulation, PSK or Zadoff-Chu sequence, and a signal duration of about 71 microseconds. These results support the suggested relation between radio frequency interferences at X-band and 4G LTE signals transmission in the 1.8GHz band, which could give out-of-band emissions exactly at the radar operating frequency (9.365 GHz).

To further assess the connection with 4G LTE systems, in-field measurement have been made during October 2018. We used a signal analyzer connected to the radar antenna, which was pointed towards the closer base stations. The results show an impulsive nature of the interfering signals with maximum peak power of -55dBm. Interfering signals may be caused by coupling between LTE symbols, whose duration is comparable with the observed disturbances, in the LTE frame. Future laboratory tests will be carry out using LTE signals generators or LTE e-NodeB to investigate which event in the LTE signal generation produces spurious emissions.

Given the increasing number of X-band radars deployed in Europe, Asia and the United States, such as the Dallas Fort Worth X-band radar network, the coexistence of the these smaller radars with telecommunications system is an important task and is the main focus of this work. Arpa Piemonte and Colorado State University are currently developing techniques to mitigate electromagnetic interferences based on signals features retrieved during in-field measurements and from radar observations.