Design of a Passive Radar Network

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***Abstract*— This paper presents a pair of tools that can be use for design of a passive radar network (PRN). The one is called RAVLA and it is suited for searching potential sites for receivers among transmitters of opportunity as well as building up a passive radar surveillance network. The other one is called PAVA and it can be used for searching potential transmitters of opportunity for the receiver located at the certain site. Both tools presume that the properties of the transmitters and the receiver are known as well as the number of bistatic bases which are needed for the location of the target. Finally, some intermediate results of the design process of a DVB-T based passive radar network in Southern Finland are considered.**

I. INTRODUCTION

Passive Radar (PR) has got a lot of attention during the last decade. The reason for that are its good properties from military point of view, independence from frequency allocation, freedom of placing and reasonable costs. A good review what has been done in this field not only the past years but also in the previous century can be found from reference [1].

One topic which has got minor attention in the field of PR is Passive Radar Network (PRN) design. The work that has been done in this area has focussed mainly to selection of optimal site for a single receiver (RX) or selection of the optimal transmitters (TXs) [2]-[4]. In [2] the authors present a methodology to determine the optimal site for the RX in a case of given TX location, given surveillance area and terrain features of the area. A method of modelling the performance of PR utilizing rigorous propagation model is considered in [3]. In [4] the authors are considering optimal site of the RX and how to choose two optimal TXs from a group of 17 TXs so that continuous monitoring of an assigned target (TG) path would be possible.

The reason for the exiguous publishing might be a consequence of problematic nature of the PRN design. The surveillance environment where the RXs should be placed to is typically non-homogenous in many ways. The density of RX network varies according to number of population. Transmission power varies also from few watts to several tens of kilo watts and the power density towards and below the horizon is much higher than it is above the horizon. Also, propagation attenuation might be totally different towards different directions.

The authors' opinion on the PRN design is that it is not possible to design large PRN cost effectively without proper design tools. Analytical methods are too complicated due to different propagation properties between TX-RX, TX-TG and TG-RX links. Also, optimisation of the RX coverage area regarding many TXs is very demanding task with analytical method. For these reasons the authors have developed a pair of tools for the PRN design. The tools which are presented in this paper are called RAVLA and PAVA. The RAVLA is suited for searching potential RX sites among TXs as well as for designing of a passive radar surveillance network. The PAVA can be used for searching optimal TXs for the RX located at a certain site.

Background information what is needed for the PRN design consist of a description of the TX network and terrain, properties of the target and the receiver, principle of the location method and naturally, performance requirements. These issues are considered in Section II. In Sections III and IV, the RAVLA and the PAVA are introduced. Some intermediate results of the design process of DVB-T based PRN in Southern Finland are considered in Section V. Few words of the further work and a conclusion and are given in Sections VI and VII.

II. BACKGROUND INFORMATION OF THE PRN DESIGN

A. TX Network

Description of the TX network is an essential thing in the PRN design. This description contains following information for each TX located on the region of interest: location, carrier frequency, power of the carrier, vertical radiation pattern of the antenna and antenna height. Also, autocorrelation properties of transmitted signals as a function of integration time as well as cross correlation properties in the case of co-channel interference are important things.

B. Terrain

Good results in the PRN design presumes that propagation attenuation of the TX-RX, TX-TG and TG-RX links are truthful. This means that the terrain and vegetation as well as antenna heights and target altitude have to be taken into account in calculation of the propagation attenuation.

C. Target

Properties of the target which are needed in the design are altitude, velocity, acceleration, bistatic radar cross section (BRCS) and a type of the fluctuation.