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A Spectrum Handoff Scheme for Optimal Network Selection in NEMO based Cognitive Radio Vehicular Networks: A Cost Function MADM Method based on Grey Theory based Approach

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Abstract

Multiple Attribute Decision Making (MADM) is one of the intelligent network selection methodologies for Intelligent Transportation System (ITS). The fundamental objective of MADM method is to select the optimal network among the finite set of alternative. In this paper, we have proposed a cost function MADM method based on the grey theory based approach which outperforms the existing MADM method for ITS. The method is validated to perform a spectrum handoff for optimal network selection in Network Mobility (NEMO) based Cognitive Radio (CR) vehicular networks. In NEMO based CR vehicular networks, the Mobile Reuter (MR) requires spectrum handoff when a mobile network changes its point of attachment in CR vehicular networks. It becomes difficult for MR to select the optimal network from the available access networks. The application of MADM methods provides wider and optimum choice among the available networks with quality of service. Numerical results revel that the proposed MADM method is effective for spectrum handoff decision for optimal network selection with reduced complexity in NEMO based CR vehicular networks.

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*Keywords:*Cognitive radio; Cost Function; CR networks; GRA; MADM; Max-min normalization; Multiple attributes; NEMO; Spectrum handoff; Vehicular networks; Intelligent Transportation System

1. Introduction

At present, the increased demand of the spectrum in vehicular communications is decreasing the vehicular communication efficiency for Intelligent Transportation System (ITS). The already allocated spectrum is insufficient

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to overcome the increased demands. This is due to the rise in the number of vehicles along with their requirement of various types of non-safety services such as voice, video and best effort services. To solve the problem of spectrum scarcity, Cognitive Radio (CR) technology [1-2] has been introduced by FCC [3]which allows to use the underutilized spectrum bands [3]. The introduced CR technology is a key enabling technology for the opportunistic spectrum usage of underutilized spectrum bands. Hence, CR vehicular networks have emerged as a smart radio for ITS. CR enabled vehicles have the ability to use additional spectrum outside the allocated spectrum band. CR vehicular nodes movement is the important characteristics in the vehicular networks. But, in some cases, network mobility becomes important where "collective mobility of a group of nodes [Network Mobility (NEMO)]" comes into the picture [4-5] such as peoples inside a car, bus, plain, and train accessing internet etc. When a mobile network changes its point of attachment in the vehicular networks, NEMO is concerned with the management of this movement. Mobile Reuter (MR) plays the important role to connect to the nodes with the network. CR vehicular node or the different entity installed on the vehicle may act as a MR. Figure 1 shows such a situation where CR vehicular node has the requirement of voice, video and best effort service. There are multiple networks available providing their services. Now, the question arises to select the optimal network for the spectrum handoff decision for a particular service in such CR vehicular networks.When MR isconnected with multiple CR enabled networks,

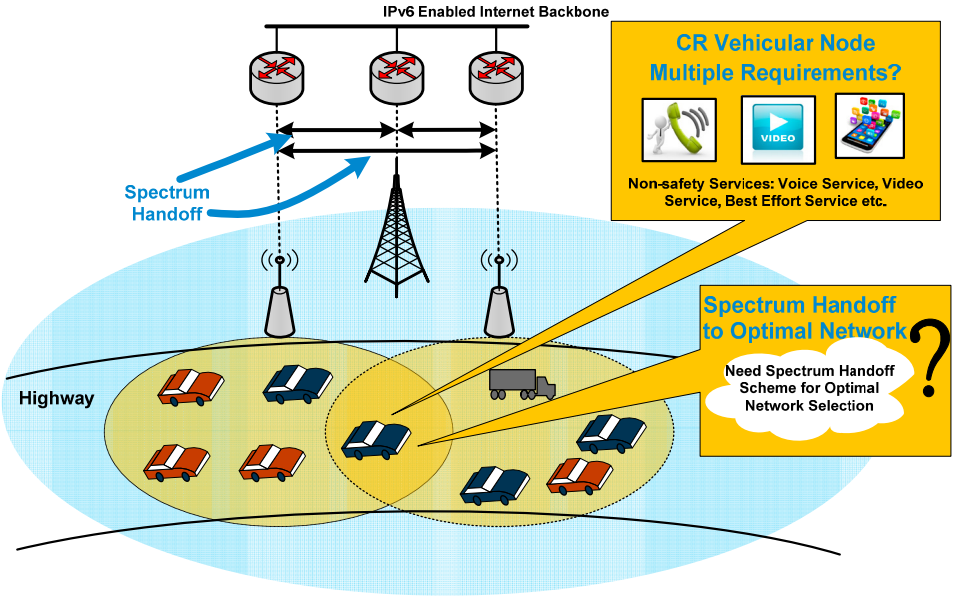

Fig. 1. System Model Showing Spectrum Handoff in NEMO based CR Vehicular Networks

then it is not easy for the MR to select the optimal network for the spectrum handoff decision. This can be done by performing spectrum handoff using multiple attributes decision making (MADM). This motivates us to develop a cost function based MADM method that is able to select the optimal network for spectrum handoff decision in NEMO based CR vehicular networks. The developed cost function based MADM method is based on the grey theory approach that uses max-min normalization. The method is inspired from GRA method [6-8] which outperform other method [9-10]. It evaluates the cost of multiple attributes of different access networks for spectrum handoff decision to select optimal network. The method provides optimized results with reduced complexity problem in the spectrum handoff in CR networks. The paper shows that proposed MADM method is effective for the spectrum handoff decision for optimal network. Thus, this paper makes following key research contributions

- The performance of the proposed MADM method is better than other methods.
- Proposed cost function MADM method based on grey theory approach and its applicability for spectrum handoff decision for the optimal network selection NEMO based CR vehicular networks.

2. Related Works

Our recent survey [1] on spectrum handoff schemes in CR networks shows that spectrum handoff is the challenging issue. It advocates that there is need to develop a spectrum handoff decision scheme which considers multiple