

Spectrum Resource Allocation among Multiple Virtual Networks Mapped Over Wireless Cellular Network

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Abstract

Virtualization has been involved in wireless networks in order to get benefits from this renowned networking technique. Wireless virtualization is an important problem to be resolved in order to synchronize wireless networks with other virtual networks. Spectrum allocation in wireless virtualization networks is famous problem of cellular networks. By successfully sharing the spectrum among different virtual networks, performance of the system can be improved significantly. This paper analyzes the performance of spectrum allocation in wireless virtual network and shows that spectrum allocation among different virtual networks can improve performance significantly.

1. Introduction:

Virtualization has revolutionized the ways of computing in modern networking systems. Virtualization involves abstraction of resources among multiple peers in order to obtain better utilization and exploitation of resources. Virtualization has been applied to several networking fields since the introduction of the concept and many technologies have taken benefit from this idea. Ranging from multiple operating systems on single machine to multiple networks on single wireless channel, virtualization finds a variety of applications in different areas of IT. Wireless virtualization is one of such emerging fields.

Wireless communication systems provide diverse environment and are based on heterogeneous behavior and varying modeling parameters. Traditional ways of implementing virtualization techniques in the domain of wireless cellular networks can't be used. The reason behind is the heterogeneous nature of wireless environment. A robust resource allocation protocol is required to allocate resources efficiently among wireless virtual networks.

Wireless virtualization is a hot topic of research today and many research groups are working on providing solutions to various problems in this field. Authors of [1] have presented a comprehensive survey on research issues and challenges of wireless virtualization.

Authors of [2] to [5] have proposed different solutions for solving the problem of wireless resource allocation in Wireless Virtual Networks.

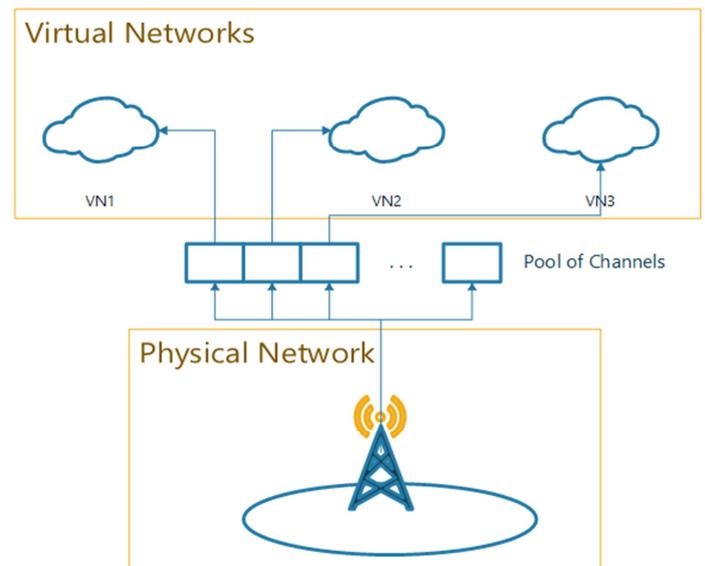


Fig 1: Wireless virtual network resource allocation model

In this paper, we have focused on the problem of resource allocation to different virtual networks. The resources in the form of spectrum are allocated to virtual networks on their request.

Rest of the document is formulated as follows. Section 2 will give brief introduction of wireless virtualization followed by problem formulation in section 3. Section 4 gives algorithm and after results in section 5, we will conclude our research work.

2. Wireless Virtualization:

Wireless virtualization is getting attention of many research groups from past few years. Wireless virtualization acts as the bottleneck problem while applying virtualization in modern networking systems. Virtualization has already been applied in wired networks like virtual private networks (VPNs).

Wireless virtualization network usually consists of two main components including

- Infrastructure Providers InP
- Virtual Networks VN

InP is set of physical infrastructure resources which are to be allocated or shared among virtual peers. While virtual networks are the networks relying upon the resources of an existing physical network.

Basic idea of wireless virtualization is to provide an abstraction of resources for virtual networks. This abstraction can help in efficiently utilizing the resources to all users of virtual networks. Wireless virtualization can enhance the performance of network resources by utilizing the virtualization layer between physical resources and virtual entities.

Before formally stating our problem, we will explain the work to be done in this paper. For a given channel from the spectrum, we want to maximize the channel utilization among multiple virtual networks while maintaining some threshold value for the channel. Multiple virtual networks may request for channel and allocation will be placed based on some features of the virtual network.

In next section, we will formulate our problem statement.

3. Problem Formulation:

Our system model is to utilize and share the channels among different Virtual Networks VNs. We assume that multiple wireless VNs are mapped to a single BSS and they share channel from it. In order to keep the model simple, we are taking C number of orthogonal channels represented by $1, 2, 3, \dots, j$ channel to be assigned to multiple virtual networks. Let X_{jk} be the variable which takes on binary value to represent if channel j is allocated or not to a virtual network k . This channel is to be assigned to n number of virtual networks. As we cannot assign this channel

to all virtual networks, so some of the virtual networks will be selected from the requesting networks. We represent the requesting virtual networks with V where k takes values from $1 \dots k$. The objective of our problem is to maximize the channel allocation to different virtual networks.

In order to prevent the channel from oversharing among virtual networks, a threshold value is to be set in order to keep the performance of channel above the required level. This threshold value can be represented by T .

4. Proposed Model:

Previous section briefly stated our problem we are going to solve. In this section, we will present the model of performance evaluation for measuring the improvements in resource allocation to wireless virtual network.

Objective of our problem is stated as follows

$$\text{Maximize } \sum_{k \in V} X_{jk} \quad \forall j \in C \quad (1)$$

Subject to:

$$\sum_{j \in C} X_{jk} \leq 1 \quad \forall k \in V \quad (2)$$

$$\sum_{k \in V} X_{jk} \leq T \quad \forall j \in C \quad (3)$$

We want to maximize the utilization of channel resource i-e maximize the number of assigned virtual networks while taking into account the maximum number of virtual networks attached to a channel under some threshold level.

Here are the constraints for keeping the connected number of resources under threshold.

These constraints limits the number of virtual networks connected with a channel while utilizing the minimum resources.

Constraint in Eq. 2 ensures that at most one resource is assigned to each virtual network. Constraint in Eq. 3 ensures that the assigned resources are kept under a threshold defined for the

channel. Value of T is taken as parameter and it is defined previously.

5. Simulation Results:

This section explains the evaluation of our proposed model for assigning and allocating the resources of a cell to multiple virtual networks.

1 to 5 number of channels C are to be shared among 10 virtual networks V . Threshold value T for each channel is selected randomly in the range of 2 to 3. We implemented our model in Julia programming language.

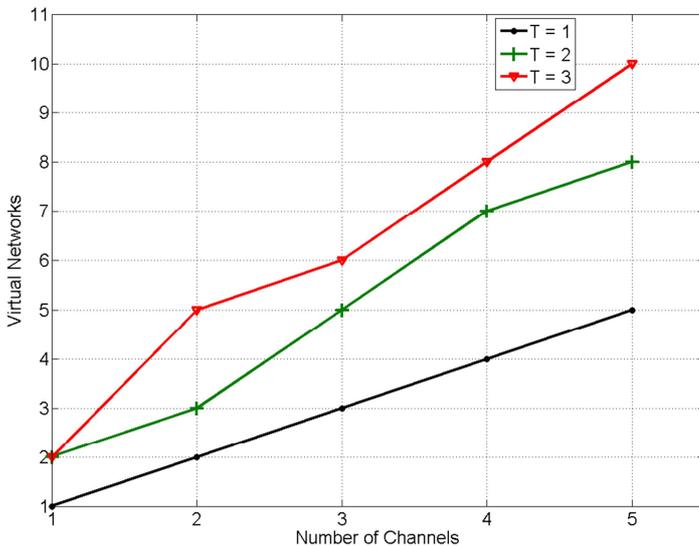


Fig 2: Simulation results for channel allocation to virtual networks

Simulation results are shown in the Fig. 2. This figure shows that as the number of channels increase, more number of virtual networks can be served. It can also be observed from the results that if we increase the threshold level of each channel, the number of supported virtual networks can be improved.

6. Conclusion and Future Work:

Wireless virtualization is an emerging field of research where virtualization concepts are utilized in wireless cellular networks in order to obtain better efficiency and utilization of resources. Traditional virtualization techniques cannot directly be applied in wireless domain due to its heterogeneous nature. Resource allocation in wireless virtual networks is a key issue. This paper presents an initial idea of sharing

the spectrum resources among multiple virtual resources.

As a future work, this paper can be improved by taking into account other aspects of resource allocation in wireless virtual networks.

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