# A Survey of Bandwidth Allocation in the Virtual Network

Sima Ahmadpour, Omar Amer Abouabdalla, Ali abdulqader Bin Salem, and Mahmoud Baklizi

***Abstract*—New services and no cooperation among Internet service providers are challenges facing by Internet nowadays. This situation is known as network ossification which makes the deployment and testing of new network technologies very difficult. Virtual network has been found as a solution for this problem which may used to make certain isolated virtual networks, sharing the physical resources of the substrate network. Meanwhile, there are some other problems through making a virtual network. Consequently, there are several solutions which have been done as well. This paper focuses on three existing solutions that have been implemented and aims to address the features of those solutions**

***Index Terms*—Network virtualization, virtual network, bandwidth allocation.**

## I. INTRODUCTION

The Internet architecture developed a couple of years ago facing by new services and requirements. However, based on its multi-provider nature, making an adoption of one new architecture or modifying current technologies need an agreement among the stakeholders who are competing. Eventually, lack of cooperation between stakeholders also becomes one of the obstacles through providing radical changes in Internet architecture [1-3].

Network virtualization has been introduced as a solution since it enables multiple networks with different policies to share the devices in one substrate. In fact, each virtual network includes virtual routers which are connected by virtual links. Each virtual router or link, respectively shares the resources of substrate's physical router and link as well [4]. Meanwhile virtual network have same characteristics of normal physical network such as routing, addressing, policing, etc. Therefore, creating virtual network as a test-bed definitely supports testing and deployment phase of a new networking technology in an architecture supporting virtual network [5].

However, service providers offer virtual network to examine the efficiency of new proposed networking technologies and also to offer end to end services to the customers in the specific environment. Obviously, physical network shares its existing bandwidth between data flows which are passing through it. While various routers and links are implemented, virtual network must consider the distribution of its own bandwidth among flows. In addition, it should consider of the total bandwidth percentage of physical network corresponded to it. In this case, virtual network needs a proper mechanism for bandwidth allocation to provide fair utilization in resources. If there is no control in bandwidth, those applications which are crossing a virtual network may use a huge percentage of physical network's total bandwidth. Therefore, there is no enough bandwidth remain for other virtual networks to satisfy their demands of the flows crossing them.

This paper focuses on bandwidth utilization as an obstacle through implementing virtual network. In section II the virtual network is defined properly. Three existing solutions are proposed in section III. Section IV is the discussion about those solutions. Finally, the conclusion has been presented.

## II. VIRTUAL NETWORK

Virtual networks can deploy new protocols and architectures independently without interruptions. Also those are fitted to allow the coexistence of different network architectures, legacy systems included. Virtualization is thus not only the enabler for the coexistence of multiple architectures, but it is also a good way for the migration of evolutionary approaches [6].

Virtualization is able to break up the "deployment stalemate" by reducing the need to create broad collaboration among the majority of stake holders with different interests that make up today's Internet. By separating the infrastructure of services and offering the ability to rent "slices" of the network infrastructure, virtualization can provide the opportunity to introduce new architectures, protocols, and services without going through the and difficult process[7].

In virtualized systems, a workload can be run in its own separated part, called a virtual machine, each with its own runtime components, including operating systems and file systems. A Virtual Machine Monitor in combination with one or more privileged virtual machines implements virtual types of physical resources, such as CPU, memory, and I/O devices. Establishing a virtual platform for the virtual machine, these virtual resources are multiplexed over the physical resources which exist on the machine [8].

A key element of virtualized systems is device virtualization. A simple method is creating a virtual device which emulates a physical one. In this case, the virtual platform provides I/O resources like the physical platform, and the guest operating system interacts with the virtual device in the same approach by using its own device driver (like it did with the physical device) [4].

Fig. 1 shows two virtual networks sharing the components of one substrate network in virtualization environment. The virtual network A includes three routers (1, 2, 4) and two virtual links from substrate, while, the virtual network B is using virtual routers (1, 3, 4) and three virtual links of the substrate.

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The authors are with the National Advanced IPv6 Centre, Universiti Sains Malaysia (e-mail: sima@)nav6.usm.my, omar@)nav6.usm.my, ali@)nav6.usm.my, mbaklizi@)nav6.usm.my).

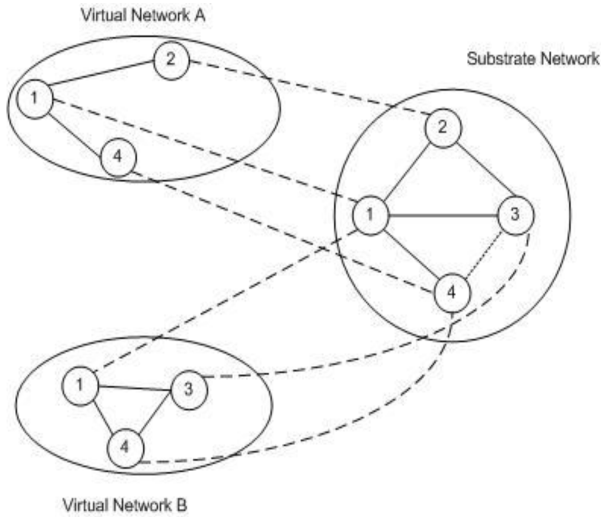


Fig. 1. A simple virtual network environment. One substrate Network providing two virtual networks [3]

## III. Existing Techniques

In this session the number of existing solutions is mentioned. They are mostly based on source routing or user controlled routing.

### *A. Bandwidth Guaranteed Multi-Path Routing (BGMR)*

In current Internet the routing functionality is merged in the infrastructure and end users have less control over the rout. This simple architecture provides a simple interface for applications and satisfied routing for broad range of services such as email, web browsing and so on. If the router forwards the data to different links in a specific rate by source-destination based routing and packed IP datagram within the same or almost same length, every single virtual link could be under a controlled traffic. In addition, with source-destination based routing the multi-path routing will be more useful and under control.

Fig. 2 shows an overview of proposed multi-path service in [9]. By using this algorithm BGMR server will find a proper route which is suitable for user's bandwidth limitation while it got a request in the remained sources. The route and bandwidth allocation on each link will be sent by server to the user which means that datagrams will be transmitted from source to destination.

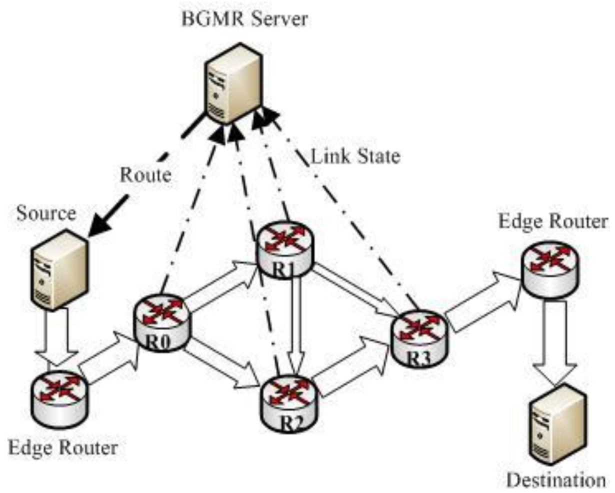


Fig. 2. Service providing BGMR [6]

This algorithm presents the design and evaluation of a service prototype which provides bandwidth that guarantee the multiple path-routing over a virtual network. Furthermore, specific route computation is developed not as a part of the infrastructure, but is provided as a service. In addition, it has been shown that packet loss rate, throughput and traffic bandwidth utilization by BGMR performs better than OSPF.

### *B. Game Based Dynamical Bandwidth Allocation*

In spite of having ability to support customized protocols, network virtualization faces a basic challenges due to share the underlying network's bandwidth. In comparison between static and dynamic bandwidth allocation it can be seen easily that Static bandwidth allocation is not efficient but it can simply cause network virtualization to perform worse than overlays. Otherwise, sharing bandwidth dynamically is better than static one but it is unstable.

In this model virtual networks and the substrate networks play a Stackelberg (leader-follower) game. It models virtual networks as competing players and results in efficient and fair distribution of link capacity. In Stackelberg game the utility functions are not available to the substrate network. So, the pricing mechanism for bandwidth allocation is considered. Therefore, virtual networks play a noncoorperative bandwidth allocation game at upper level as a followers while, the substrate sets a price to maximize social welfare in lower level as a leader. In this case, the implementation of the bandwidth allocation game should be above than the substrate network in a distributed manner [10].

### *C. Bandwidth Allocation among Bottlenecked Virtual Networks*

Having no control in bandwidth allocation may create a bottlenecked virtual network. Bottlenecked virtual network will happen in case when at least one of its virtual links is bottlenecked. In [4] they focused on the problems occur while one or more virtual network is bottlenecked.

Obviously, the fairest allocation is to have an equal division of the physical link's bandwidth among virtual links. This content is not acceptable since there are two possible types of connections:

1) Restricted: equal division of link among existing connections may cause a problem in which restricted ones may receive more bandwidth than they need. Therefore, other links with less capacity or huge number of connections may receive lower bandwidth than they need.
2) Unrestricted: Connections limited due to the bandwidth of the current link

Proposed algorithm in [3], allocates the bandwidth among restricted connections as a first step; secondly the remained bandwidth is distributed among unrestricted connections equally. On the other hand, this strategy maximizes the minimum values of the restricted flows to avoid the strangulation of the virtual networks.

## IV. Discussion

In order to solve bandwidth allocation which is noted as the main problem of this paper, above mentioned existing solutions have their own features as showed in the table below.

TABLE I: EXISTING FEATURES OF THREE SOLUTIONS

| BGMR | bottlenecked | Game Based |
|---|---|---|
| Under control routing | Avoid the strangulation | Dynamic sharing of bandwidth |
| Packet loss rate performs better than OSPF | Avoid wasting bandwidth | No need for global information |
| Bandwidth utilization performs better than OSPF | Fairness | Unstable allocation |

Considering those above mentioned solutions which make proper bandwidth allocation, choosing the best one is depends on the characteristic of the network.

1) Bandwidth Guaranteed Multi-path Routing (BGMR) technique is suitable in multi-path services. In this solution, making any routing by the multi-path routing is under control. In comparison, packet loss rate, throughput and traffic bandwidth utilization by BGMR performs better than OSPF.
2) Game based technique is normally use for dynamic bandwidth allocation between virtual networks. Game based dynamical bandwidth allocation is sharing the bandwidth dynamically which causes unstable allocation and eventually it works better than the static one. Using pricing mechanism in Stackelberg model forced virtual networks to act properly along with maximum social welfare. The important factor of this method is that the link updates just local information which use that link and therefore global information is not require.
3) Finally, proposed model in bottlenecked virtual network bandwidth is allocating among restricted links first and then remained bandwidth has been divided in unrestricted one therefore wasting bandwidth in bottlenecked links will not be happened.

## V. CONCLUSION

In this paper virtual network has been introduced as a solution for overcoming the problem caused by new services due to having no coordination in internet service providers. In consequence, bandwidth allocation appeared as an obstacle through implementing virtual networks. Three different algorithms have been noted as existing solutions which have been discussed.

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