LCN Demo Proposal: Concurrent use of WiFi channels to provide QoS

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***Abstract*—We propose demonstrating a prototype system intended to improve the performance of VoIP over WLAN. It is well known that VoIP over WLAN performs poorly with unacceptable delay occurring at very low levels of utilization. A suggestion has been to move VoIP flows to a separate WLAN channel or Access Point optimized for VoIP. Our demonstration makes use of our work into traffic classifiers that identify VoIP. We show that it is possible to identify VoIP over WLAN and move it to an Access Point specifically for VoIP.**

I. Introduction

With the widespread proliferation of wireless devices, public access to mobile Internet services via 802.11 is becoming more common. A side affect of increased availability of 802.11 access is increased usage of these services by the general public. A problem arises with a public access network in that the applications that users choose may not be beneficial to overall network performance. While some users will only need access for web-browsing, others will download/upload content, while other people will be using realtime streaming services such as Voice-over-IP (VoIP).

Unfortunately, different application types do not work well over a shared medium, where realtime services can dramatically affect the data transfer rates of non-realtime applications, while heavy data traffic impacts on the maximum number of concurrent realtime streams that can be carried by 802.11 [1], [2]. These problems are exacerbated in large stadium-type scenarios, where thousands of mobile devices access the network through a small number of wireless access points.

While some recent Quality-of-Service (QoS) based 802.11 extensions allow network administrators to tweak the performance of their networks to better handle this load, the benefits are limited [1].

We propose a scenario whereby traffic classes are split over various access points, with regular data traffic carried on one channel, and realtime traffic carried on another channel. In this case the mobile access devices associate with two (or more) access points concurrently, and traffic is routed based on application type. Our system uses our prior work in realtime traffic classification to detect and classify traffic into realtime and non-realtime classes. This information is used to distribute the classification outcomes to routing nodes which then manage the application-based routing [3]. In this way a mobile device can use both access points simultaneously, garnering maximum performance for both realtime traffic and data traffic (due to the absence of competing traffic classes on the corresponding channels).

This demonstration is a proof-of-concept to verify the practical aspects of the ultimate goal. In particular, our demonstration will show that traffic from a mobile device with a single wireless network interface card (NIC) can associate with two access points concurrently. We will also show that traffic can be selectively routed via selected access points based on simple flow matching rules.

II. Crowd Usage of Wireless Access Services

Voice over IP (VoIP) is one of the fastest growing services on the Internet today [2] . Many consumers and businesses now use VoIP to lower their communication costs. As the voice traffic is delivered over the underlying IP network, it can converge with data services, and as such can provide unified communication. Mobile and wireless VoIP solutions are an important emerging service as it promises to replace cell phone communication wherever a wireless local area network (WLAN) is available. Decreasing costs for WLAN equipment and improvements to the IEEE 802.11 protocol have led to a widespread deployment of wireless networks. Many places such as cafes, restaurants or airport lounges now offer free WLAN access. However, recent studies [1], [2] have shown that VoIP over WLAN suffers from degraded service at remarkably low levels of utilization.

The number of VoIP flows over WLAN is not limited by bandwidth, but rather from the Access Point acting as a point of contention. According to [1] VoIP flows over 802.11b WLAN experience unacceptable delay as a result of contention when the WLAN link carries only 7 calls, representing less than 1% of the channel capacity. The situation is made even worse if other non-realtime traffic is also contending for the channel.

This can be significantly improved if VoIP traffic is isolated onto a single Access Point [4]. However, identifying and moving these flows is a challenge. In the following section we discuss our approach to this.

TABLE I
PERFORMANCE OF SUB-FLOW BASED CLASSIFIERS

ML Classifier	Recall	Precision
First Person Shooter	96%	97%
Skype	99%	98%
BitTorrent	97%	94%
Generalised VoIP	90%	99%

III. SPLITTING TRAFFIC CLASSES BETWEEN WIFI CHANNELS

One possible solution to the problem outlined above is to use different WiFi channels to carry different application classes. In essence, the data traffic and realtime traffic do not interfere with each other because they are carried over a different frequency, and are processed by different wireless access points.

There are two implementation problems that need to be overcome prior to putting such a solution in place. The first issue is how to ensure that traffic is routed via two – or more – different paths. This needs to be handled both within the network and on the mobile device itself. In essence we need to perform traffic class based routing, setting alternate next-hop gateways based on what application generated the flow. Putting aside how we determine that a packet belongs to a particular class, on Linux based systems, `iptables` firewall rules can be deployed to redirect packets that match particular conditions to specific next-hop IP addresses [5].

If this approach is applied at routers within the network and on the mobile devices, then it is possible to selectively route packets out alternate interfaces to selected wireless access points. However, most mobile devices have a single wireless NIC. Using features of the Linux networking stack, it is possible to create wireless sub-interfaces, and have a wireless NIC associate with two access points simultaneously. Each mobile device receives multiple IP addresses tied to each access point. As such, the approach outlined above is able to use a single NIC, and to actively switch between wireless channels/access points for individual data packets.

IV. CLASSIFICATION OF TRAFFIC

The previous section assumed that we would be able to identify to which traffic class an individual packet belonged. In our previous work [6], [7] we have developed a Machine Learning technique using subflows that can be deployed to perform near-realtime classification of network flows with good accuracy. The subflow technique also allows for regular reclassification of flows, allowing for correction of previously incorrect classifications.

Table I summarises the Recall/Precision that has been achieved for the classification of various traffic classes [8]–[10]. As is evident in the results, classification performance is good. Further modifications to the subflow classification technique that utilise a feedback loop have been proposed that improves performance [11].

In this problem space, we would like to classify generic VoIP traffic. The general classifier identified in [9] has reasonable performance. We speculate that this performance can be significantly improved through application of the feedback algorithms described in [11].

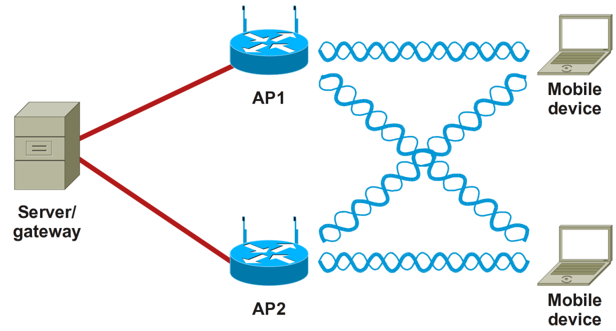

Fig. 1. Proposed demonstration configuration

DIFFUSE [3] is a practical implementation of a ML-based classifier that deploys the subflow technique, and one which can be programmed to send messages to remote systems on classification of flows of certain types. We propose that DIFFUSE be deployed in the network to classify realtime VoIP flows, and then to communicate this information to relevant routers and mobile devices which can then implement any relevant application-based routing rules.

V. LCN DEMONSTRATION

We would like to demonstrate a proof-of-concept testbed as per Figure 1. Our testbed will consist of two wireless devices, each simultaneously connected to two access points. A fixed computer will act as a server/router on the network, connected to the wired interfaces of both wireless access points.

The demonstration will consist of two traffic generating applications running on each wireless device. While each wireless device is associated with both access points, all traffic will be sent via AP1. A user interface will be provided on each wireless device to cause traffic from selected applications to switch across to AP2. By running a tcpdump session on both the wireless devices and the fixed computer, we will be able to demonstrate that the path that traffic takes through the wireless network can be programatically specified.

The demonstration will also consist of a poster summarising the intended application with the use of DIFFUSE and traffic classficiation to control the dynamic routing, and with measures of the accuracy that is achievable by the ML subflow approach (as summarised in Table I above).

In order to run the demonstration we will require a table with multiple power outlets to drive the equipment and a pinboard to display our poster. We will provide the computing and networking equipment.

VI. CONCLUSION

The recent proliferation of mobile networked devices with 802.11 capabilities has led to widespread deployment of public 802.11 access points. The increase in availability of these networks will result in more people using them. Unfortunately, the traffic generated by different application classes do not coexist nicely over the shared medium of a single wireless access point. While certain extensions to 802.11 can improve the QoS, better outcomes can be achieved by segregating traffic onto different channels utilising multiple wireless access points.

The benefits to be achieved by segregating traffic will be maximised in stadium-like scenarios where many thousands of users are congregated in a small area, each vying for usage of available wireless capacity. We propose to build a system whereby mobile devices connect to multiple wireless access points concurrently, and can selectively route traffic to these access points. In turn, a network-based system running software like DIFFUSE can be used to remotely classify the application class of unique flows, and then signal both the network and the mobile devices which access point should be used for specific flows. An eventual deployment will result in increased throughput for data users as VoIP traffic is not stealing their bandwidth, along with increased performance for VoIP users as a clear channel will allow for both more concurrent calls and for more consistent network round trip times.

In this demonstration we will display a proof-of-concept system that verifies that the underlying technologies will allow for such a solution to work. We will demonstrate a that a mobile device with a single wireless NIC can associate with multiple access points simultaneously, and can selectively route traffic to either of the connected access points.

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