Gossipmule: Scanning and Disseminating Information between Stations in Cooperative WLANs

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ABSTRACT

In Cooperative WLAN scenarios, the lack of a centralized management, the existence of many administrative domains and the current association process in wireless networks make it difficult to guarantee the quality that users expect from services and networks.

We present Gossipmule, an agent for wireless nodes that enhances the QoE perceived by users in Cooperative WLANs. Gossipmule uses mobile Crowdsensing between the wireless nodes to collect and disseminate information regarding the network. This information is used by the agent to have a more assertive association when making decisions regarding the user-AP association.

Categories and Subject Descriptors

C.4 [**Computer Systems Organizations**]: Performance of Systems

General Terms

Performance

Keywords

Quality of Experience, Crowdsensing, Network-aware association, opportunistic networking, Cooperative WLANs

1. MOTIVATION

Nowadays connectivity is a must for users in many regions of the planet. This connectivity is defined by users in terms of an access to services anywhere, anytime and with any device. Consequently, according to Cisco [3], mobile data traffic will increase 26 times between 2010 and 2015 in a global scale as a consequence of the growing popularity of mobile devices. These trends are the engine of the development of strategies that take advantage of opportunistic communication.

One field where opportunistic communication could play an important role is in the enhancement of the Quality of Experience (QoE) perceived by wireless users. For instance, the current association services in IEEE 802.11 networks lack QoE mechanisms to enhance the connectivity experience of the user; a poor selection mechanism and high latency are the main problems which are addressed by our proposal.

We propose to use Crowdsensing [4] as a mechanism to gather the required information in a decentralized way for an optimal association, which satisfies the quality requirements of users. In our approach, users collect relevant information regarding the current performance capabilities of the Access Points (APs) that are reachable for their user interfaces, as well as features related with the Basic Service Set (BSS) in which the user has been associated (i.e. realtime traffic patterns).

This sensing provides a partial knowledge about the network topology and conditions for the user. Afterwards we take advantage of the opportunistic communication between mobile users. The user exchanges his information with other users, in order to enhance his association decisions regarding the most suitable AP according with his necessities.

In this paper we address the research challenges using crowdsensing for the enhancement of the QoE perceived by the user. Based on this idea we propose a novel architecture using a sofware agent in the WLAN.

2. ASSOCIATION SERVICES IN IEEE 802.11

The three association related services in IEEE Std.802.11 [5] are association, reassociation and disassociation. Before a user can transmit information in a WLAN, the user or station (STA) should be first associated. During the association and reassociation, the STA scans the medium for Beacon frames to know what APs are present. After this, the STA chooses an AP in a BSS based on the strongest RSSI (Receive Signal Strength Indicator) value.

This process does not lead to the selection of the best Access Point (AP) that satisfies the connectivity requirements of the user, since it does not consider relevant metrics that have a strong impact on the performance [6] [1].

To improve the current association process and hence the QoE besides the RSSI value, additional information regarding the AP capabilities and performance is required by the user to make a smarter decision, i.e. number of associated users, load of the AP, airtime, among others.

The same problem affects the handoff process in WLAN. When the user is changing his association due to the availability of the AP or to the mobility, the user chooses an AP to establish a new association based on the RSSI value.

This QoE problem is exacerbated due to the high handoff latency that occurs during the scanning process of the handoff. Mishra et al. [6] have demonstrated that the reassociation delay in WLAN is about 50-400 ms and over of

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90% of this time corresponds to scanning. It is important to point out that streaming, VoIP, among others applications are sensitive to high delays, thus latency handoff has a high impact on the QoE of the users. This effect is even more dramatic if we take into account that during the reassociation process the STAs are not able to receive or transmit information.

This reassociation latency would be reduced if the STAs have previous knowledge about the network topology and conditions, before the scanning process starts. Therefore, if we could reduce this reassociation latency, the effective transmission time will be increased, enhancing the perceived quality by the user.

Many approaches have been proposed in order to optimize the way that the STAs choose the AP [2] [1], but those approaches are centralized, demand more resources (additional interfaces) or depend on the information provided solely by the AP.

3. APPROACH IN DETAIL

3.1 Gossiper Design

The main part of this proposal is the gossiper agent which handles the collection, storage, evaluation and exchange of data. The mobility of wireless users is a feature that can be exploited in order to exchange information between STAs and collaborate in the enhancement of the overall QoE of the network.

When a user is scanning for a new AP, parameters such as load of an AP or the number of associated STAs will permit the user to take a more accurate decision when choosing a new AP to associate with. This information is broadcasted by the AP as beacon stuffing using some of the QoS capabilities that are defined in the IEEE 802.11e Standard. Additional metrics are calculated by the STA (i.e. airtime) based on the information that is sent by the neighboring STAs and by the AP.

Data exchange is done by using a part of the IEEE Std. 802.11v which supports multiple networks. Legacy 802.11 restricts data exchange to one network but as a new node does not have any association to an AP, the data has to be transmitted in a separate ad-hoc network. Therefore, using the IEEE Std. 802.11v, we are able to form a new network with a fixed SSID for our gossiper traffic. After the collection of this information, the user has to extract relevant information that allows him to build an AP preference list. In this way, when a STA requests data regarding the network topology, the agent disseminates opportunistically his current AP preference list.

Upon gathering a new data set for a potential list entry, the agent evaluates the data with regard to QoE and stores the AP in the list. Data which is not usable, for example if the data set is too old, is dropped and the list remains unchanged.

Additionally, based on the spatial and temporal relationships between wireless nodes. The STAs in our approach are able to disseminate information that already has been downloaded from other STAs. The sharing of data between the users increase the performance of the BSS reducing the overload of the AP.

Our approach is legacy compatible since STAs which do not support the gossiper module will then just ignore this additionally transmitted data.

3.2 Implementation

To get the gossiper module working as intended, some changes have to be made in the network device in addition to adding the gossiper agent as an application.

On the AP side we have to enable data gathering (e.g. number of STAs connected to the AP, load of the AP) and alter the beacon generation to fill in the additional data via beacon stuffing.

On STA side the gossiper module has to be implemented in the application layer. Additionally, we alter the MAC layer behavior to serve three additional purposes. First, extract QoS data from beacon frames and the gossiper data from probe frames, which we currently use as a wrapper. Second, add additional data provided by the agent to sent frames and third, enable virtual network support using specifications provided by 802.11v. The gossiper agent itself consists of an array containing the stored AP list including the data we evaluated to build it as well as management functionalities to handle requests and list exchange.

4. FUTURE WORK

Currently we are evaluating the presented approach using ns-3 as a network simulator in order to measurement the performance of opportunistic communication. Later on we would like to evaluate the consistency of our results in a testbed implementation.

Our future work will mainly focused on (1) Analyzing the Human mobility traces to make an smarter decision regarding target users with whom to exchange information, (2) Data quality with respect to the integrity and validity of the data that is exchanged and (3) Privacy issues during the opportunistic communication.

5. ACKNOWLEDGMENTS

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