Investigating the User Mobility in Wireless Mobile Networks through Real Measurements

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ABSTRACT

In this paper is proposed a real mobility characterization study for wireless devices. For this, we use mobility metrics and statistic analysis to evaluate the behavior of device movement components.

Categories and Subject Descriptors

C.2.0 [**General**]: Wireless Networks

General Terms

Measurement, Performance

Keywords

Wireless Networks, Mobility, Characterization

1. INTRODUCTION AND MOTIVATION

Mobility has been a very important component in wireless and mobile networks performance evaluation. There are two ways of representing the movement pattern of the users in mobile networks. One of them is through the use of mobility models, and another one is through the use of real traces. Mobility models are used to represent synthetically the mobility pattern of the devices and are the most used in wireless networks evaluation, mainly in the Mobile Ad Hoc Networks - MANETs. Despite representing the reality, to use traces is the most appropriated way to represent the motion, but is not common because to keep track of movement of the nodes is not an easy task in MANETs. In this case the use of the mobility models is required.

There are a great number of the researchers using the Random Waypoint (RWP) model in its evaluations, but this model does not represent a realistic behavior. Moreover, currently a considerable number of imperfections and undesirable behaviors had been founded and analyzed in this mobility model [5] and in others models and simulations parameters for MANETs [4].

For the reasons explained above, in [1] was proposed the IMPORTANT framework to systematically analyze the mobility impact on the performance of the routing protocols for MANETs. For this, mobility and connectivity graph metrics were proposed, independently of the protocols. The frameworks comprise the following aspects: mobility models, metrics for the mobility and connectivity graph characterization and the relationship between mobility and the routing performance. This framework is a great contribution to mobility model evaluation, aiming at the level of realism of the synthetic models for the simulation of mobility in MANETs. Therefore, the proposed metrics to evaluate the movement behavior and the network topology are totally independent from the protocols, which allow a mobility model behavior evaluation. The proposed metrics in that work permit a new phase in the performance evaluation of the routing protocols. However, all the obtained results in [1] were carried out from synthetic data, instead of using mobility real data.

Currently, the real data measurements in Wireless Local Area Networks (WLAN) has been developed (for example, the CRAWDAD project [3]), and new observation are carried out about human mobility and its impact on wireless networks protocols [2]. This approach can be applied in MANETs, so this work proposes a characterization of mobility through measurement.

2. CHARACTERIZATION PROPOSAL

The main goal of this proposal is to investigate the mobility real data captured to extract a more accurate knowledge about devices movement. At first, it will be applied a statistical analysis to the captured movement components. This analysis consists in calculating some performance metrics for the evaluated components, such as average, standard deviation, variance, confidence level, correlation between the components, auto-correlation of components, relative frequency and cumulative frequency. Later, it will be investigated a possible occurrence of specific and/or similar behaviors in captured mobility data by applying a quantitative and qualitative analysis through the above mentioned metrics. Finally, this research has the goal to detect specific mobility patterns. This characterization is important in order to have a more adequate representation of the reality.

Moreover, it will be investigated if the behavior of the components in the collected data matches, if possible, with some known probability distribution found in literature. This

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approach will be given through the proximity level between the samples component values and the probability distribution parameters. Kolmogorov-Smirnov and QQ-Plot numerical methods will be used for this analysis. This inquiry will allow a formal comparison between the real data and the synthetic data, which is a comparison between the real mobility and the synthetic models. For example, to verify the realism level of a synthetic model, as the RWP model, or to verify how much a synthetic model is more adjusted to a specific scenario.

With this characterization methodology we expect to reach the following contributions: (i) - deeper knowledge of user mobility in some real scenarios; (ii) - the accuracy of synthetic mobility models; (iii) - important data set for the development of more realistic mobility models.

3. PRELIMINARY RESULTS AND CONSIDERATIONS

A set of experiments was carried out at UFRJ campus, in the city of Rio de Janeiro, with duration of about two hours. For the capture of the movement a Trimble GEO XT GPS with high precision (error level sub-meter after approximately 30 min of calibration) was used. The movement collection of people walking in the campus and the localization position was collected in the interval of 1 second. These traces did not suffer filtering procedure. Figure 1 illustrates the movement pattern collected by the traces.

Figure 1: Mobility traces at UFRJ campus

The focus of this work is to analyze the velocity variation of people at the university campus. In this context, Figure 2 presents the behavior of instantaneous velocity, with average equal to 1.05 m/s.

In Figure 3, the relative frequency of people walking, with an interval at 0.025 m/s, is shown. As a preliminary result, it can be observed that this graphic behaves similar to a Gaussian distribution. Due to space limitation, some results can not be presented.

The preliminary results presented in this section motivate the use of the proposed methodology. After interpretation of these results, it can be concluded that, for the accomplishment of this evaluation the use of GPS with high precision is necessary. Otherwise, without this high precision equipment, some errors in the calculation of the movement components can compromise the characterization accuracy, since this analysis involves device micro-mobility. As future work, we intend to conclude the proposed characterization, realizing a lot of experiments for a complete analysis of real device mobility. Moreover, it will be realized a comparison between synthetic model components and real mobility.

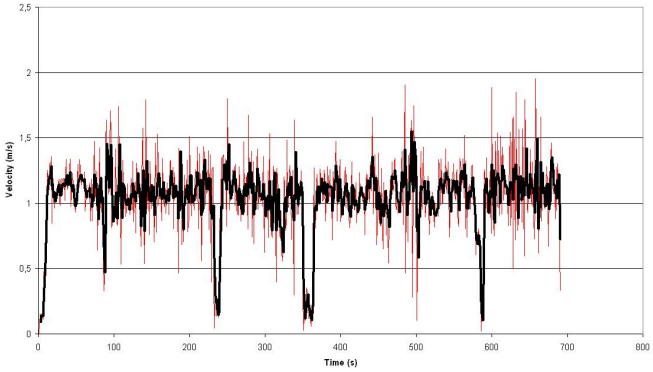

Figure 2: Velocity behavior on the time

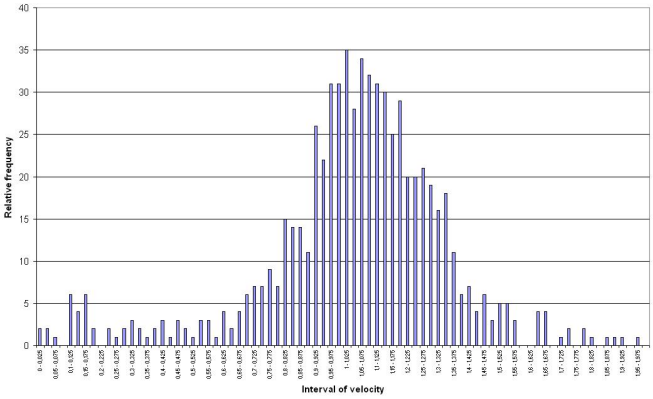

Figure 3: Velocity relative frequency at 0.05 m/s

4. ACKNOWLEDGMENTS

This work has been partially supported by CNPQ and FINEP. The authors would like to thank the CoNext Committee for the travel grant conceded.

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