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A rate control video dissemination solution for extremely dynamic vehicular ad hoc networks

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ABSTRACT

Video dissemination to a group of vehicles is one of the many fundamental services envisioned for Vehicular Ad hoc Networks, especially as a building block for entertainment applications. For this purpose, in this paper we describe VoV, a video dissemination protocol that operates under extremely dynamic road traffic conditions. Contrary to most existing approaches that focus exclusively on always-connected networks and tackle the broadcast storm problem inherent to them, VoV is designed to operate under any kind of road traffic condition. We propose a new geographic-based broadcast suppression mechanism that gives a higher priority to rebroadcast to vehicles inside especial forwarding zones. Furthermore, vehicles store and carry received messages in a local buffer in order to forward them to vehicles that were not covered by the first dissemination process, probably as a result of collisions or intermittent disconnections. Finally, VoV employs a rate control mechanism that sets the pace at which messages must be transmitted according to the perceived network data traffic, thus avoiding channel overloading. Therefore, VoV adapts not only to the perceived road traffic condition, but also to the perceived channel quality. When compared to two related and well-accepted solutions – ABSM and AID – under Manhattan grid and real city scenarios, we show that, overall, our proposal is more efficient in terms of message delivery, delay and overhead.

1. Introduction

Vehicular Ad hoc Networks (VANETs) are finally leaving the labs and are gaining the streets [1,2]. In these networks, vehicles are equipped with wireless networking interfaces for communicating with nearby vehicles and roadside units (RSU), thus enabling the development of traffic safety, management and entertainment applications. In this context, the scientific and auto maker communities envision video dissemination in VANETs as a fundamental service for both traffic management and entertainment applications [3–5]. For instance, it is unquestionable that disseminating a video showing lines of cars stuck in traffic conveys a more compelling message to a driver deciding which route to take than a text message

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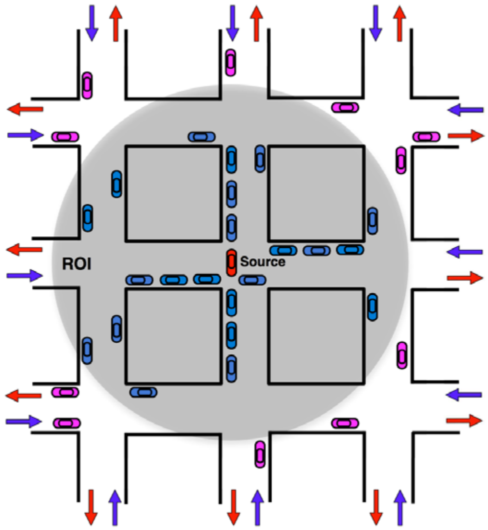

Fig. 1. A source vehicle produces a short video showing the traffic jam at a given point in the city and disseminates it to all vehicles inside the region of interest (ROI) defined by the application.

stating that there is a heavy traffic condition at a region of a city. Consider the example shown in Fig. 1. After perceiving a traffic jam, the source vehicle produces a short video showing all nearby vehicles stuck in traffic and disseminates it to all vehicles in a region of interest (ROI) defined by the application. Therefore, when a vehicle receives the video and the driver notices the heavy traffic, it can avoid the problematic region and take an alternative route.

Toward this task, many solutions have been proposed in the literature [6–12]. Surprisingly, most of them were designed for always-connected networks, in which a path from the source vehicle to intended recipients is always guaranteed. Furthermore, relying on fixed infrastructures, such as roadside units and repeaters at intersections, is common practice. However, it is common knowledge that VANETs are inherently intermittently connected networks, independently of the traffic density, due to non-uniform demographic distribution of vehicles, time variations in congestion conditions or simply traffic lights [13–15]. Besides, during the first years of VANETs deployments, the number of vehicles equipped with DSRC technology [16] and the availability of fixed infrastructure may not be enough for the proper functioning of existing video dissemination solutions.

With these issues in mind, in this paper we start from our previous work on video broadcasting [17] to propose the Video over VANETs (VoV), a video dissemination protocol for VANETs that works under the most diverse road traffic conditions inherent to these networks. For high traffic densities, VoV employs a geographic-based broadcast suppression mechanism that chooses vehicles inside high priority regions to rebroadcast. Therefore, vehicles inside these regions are assigned lower waiting delays to rebroadcast. Furthermore, after receiving a message, vehicles store it in a local buffer to be later forwarded to *uninformed neighbors* that failed to receive it in the primary dissemination process. We show that this increases the message delivery capability for our protocol not just for sparse road traffic scenarios, but also for heavy traffic conditions, since it works as a recovery mechanism for message losses caused by collisions. Due to the demanding nature of video dissemination, such as high bandwidth usage and strict time delivery requirements, here we extend our previous solution and propose a rate control mechanism that adapts the rate at which messages are inserted into the channel in order to avoid channel overload. Therefore, we argue that our new solution is adaptable not only to the perceived road traffic condition, but also to the available bandwidth on the communication channel. By means of simulations, we compare our proposal to two existing and well-accepted solutions – ABSM [18] and AID [6] – under Manhattan grid and real city scenarios, and we show that, overall, our protocol delivers more messages in the least amount of time by consuming less network resources. Finally, when compared to our previous work, the main contributions of this paper are the following:

- Like in [17], VoV also operates under diverse road traffic conditions. However, here, VoV employs a rate control mechanism, which turns this solution adaptable to the perceived network data traffic condition. We show that this increases the reliability and decreases the overhead of our proposed solution.
- Unlike in [17], here we assess the behavior of all protocols under Manhattan grid and real city scenarios. In particular, for the real city scenario, we rely on realistic mobility data from the city of Cologne, Germany [15] in order to increase the reliability of our results.

The remainder of this paper is organized as follows. In Section 2, we outline the related work and describe the two protocols used in our performance analysis. In Section 3, we describe in detail our proposed solution. Then, in Section 4, we compare our proposed protocol to two existing solutions in the literature under different road traffic scenarios. Finally, in Section 5, we present our final remarks and discuss some future work.