Chapter 13
A Disaster Management Specific Mobility Model for Flying Ad-Hoc Network

Amartya Mukherjee
Institute of Engineering and Management, India

Nilanjan Dey
Techno India College of Technology, India

Noreen Kausar
Alfaisal University, Saudi Arabia

Amira S. Ashour
Tanta University, Egypt

Redha Taiar
Université de Reims Champagne Ardennes, France

Aboul Ella Hassanien
Cairo University, Egypt & Beni Suef University, Egypt & Scientific Research Group in Egypt (SRGE), Egypt

ABSTRACT

The extended Mobile Ad-hoc Network architecture is a paramount research domain due to a wide enhancement of smart phone and open source Unmanned Aerial Vehicle (UAV) technology. The novelty of the current work is to design a disaster aware mobility modeling for a Flying Ad-hoc network infrastructure, where the UAV group is considered as nodes of such ecosystem. This can perform a collaborative task of a message relay, where the mobility modeling under a "Post Disaster" is the main subject of interest, which is proposed with a multi-UAV prototype test bed. The impact of various parameters like UAV node attitude, geometric dilution precision of satellite, Global Positioning System visibility, and real life atmospheric upon the mobility model is analyzed. The results are mapped with the realistic disaster situation. A cluster based mobility model using the map oriented navigation of nodes is emulated with the prototype test bed.

DOI: 10.4018/978-1-5225-6195-8.ch013

1. INTRODUCTION

The extended Mobile Ad-hoc Network (MANET) and Vehicular Ad-hoc networks (VANET) are the most emerging research domains in contemporary decade. MANET can be visualized as a group of network nodes that can perform a collaborative task. In such case, the network nodes may be homogeneous or heterogeneous type where the different nodes may use the same (for homogeneous) or diverse (of heterogeneous) network protocol or routing methodology. In addition, the network node can have different kind of nature based on the node movement. Based on the physical location of the network, the velocity of the nodes can be the same or different.

Typically, the vehicular Ad-hoc network is a subset of MANET that has been deployed within a group of the ground vehicle. The majority of such network cases consist of a series of vehicles that can generate a connectivity to establish an Internet infrastructure. The movement model in their case is considered to be non-randomized and organized movement fashion. Several routing (Vieira et al., 2013) methodology and mobility model (Longjiang et al., 2013) has been described beneath this philosophy.

There are several classifications can be considered for the network architecture, such as pure cellular or Wireless local area network (LAN), hybrid, pure Ad-hoc (Bruno et al., 2005; Sarkar et al., 2007; Katsaounis et al., 2014). In pure cellular or wireless LAN architecture, the communication between the vehicle and the gateway has been done using cellular tower. In Ad-hoc category, the data acquired by a sensor have been relayed from one vehicle to another. In the hybrid architecture, both cellular towers as well as the vehicles take the same responsibility to perform the message transfer. The routing protocol such as Ad-hoc on demand distance vector (AODV) (Santhiya et al., 2014), Preferred group broadcasting (PGB) (Lee et al., 2010), Intelligent Dynamic Source Routing (DSR) (Akhter & Singh, 2013), Temporarily Ordered Routing Algorithm (TORA) (Weiss et al., 2005) are the basic back bone of such infrastructure. Amongst that, some couple of traffic specific routing scheme, such as the shortest path based geographical source routing GSR (Cadger et al., 2013). Anchor based street and traffic aware routing (A-STAR), Street topology based routing (STBR) (Paul et al., 2012) and Greedy traffic aware routing (GyTAR) (Ren et al., 2011) are the most frequently introduced schemes.

In the case of mobility modeling perspective VANET (Vehicular ad hoc networks), it can run on several categories of synthetic model (Zhang et al., 2013). The node can move randomly, maintaining a hydrodynamic phenomenon or moves such as the element of First-in-first-out (FIFO) queue. The vehicle mobility can be viewed in macroscopic or microscopic phenomena (Mitsakis et al., 2014). In macroscopic model, the entire motion constrains are to be considered such as streets, road junctions and traffic lights. Therefore, the node's mobility is predefined with respect to a geographical region and highly depends upon topological maps, obstacles, event points, non random distributions of vehicles driving pattern. Microscopic model is more focused on the behavior of individual vehicles. Although such architectures are widely used in various real life applications, there are some sort of VANET limitations that to be considered in emergency situations, such as earthquake, flood, and cyclone.

The main disadvantage in this context is that a VANET follows an organized movement path to establish the Internet infrastructure amongst *n* number of ground vehicle by applying several reactive, proactive and position based routing protocol. The VANET infrastructure cannot be easily deployed where disaster scenario is concerned, as the organized path is hardly available. Due to the current technological enhancement in the last three years, especially the advancement of on board Micro Electro Mechanical System (MEMS) sensor (Degawa et al., 2014) and open source rapid prototyping technology (Lin et