Integrating MANET with the Internet

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The Mobile ad hoc Network (MANET) is a collection of mobile devices that forms a self-created, self-administered, and self-organized network. It is an infrastructureless network that does not require an existing infrastructure to operate. MANET suits scenarios where a temporary network is needed, such as emergency rescue, the military field, and disaster areas. MANET is an isolated network, and communication is restricted to the participating nodes' transmission coverage. In order to increase its connectivity and its application scope, however, MANET requires integration with other networks, forming a hybrid MANET. The integration of MANET and IP networks raises many challenges and issues. Mobility management is one of the main challenges.

MANET AD HOC MOBILITY

1. Introduction

The Mobile ad hoc Network (MANET) is an autonomous collection of mobile devices that forms a self-created, self-administered, and self-organized network. The topology of MANET is dynamic, and it is therefore susceptible to unpredictable changes. MANET nodes collaborate with each other to route traffic between themselves. As mobile nodes are characterized by their limited transmission range, multi-hop communication is required to enable out-of-range communication. MANET is an infrastructureless network and can be deployed easily, hence, it suits scenarios where a temporary network is required, such as emergency rescue, the military field, disaster areas, and Unmanned Arial Vehicles (UAVs), which are commonly known as drones. Additionally, MANET can interact with other technologies in smart environments such as Internet of Things IoT and Wireless Sensor Networks (WSN) [1] making it more economically appealing. Such smart environment can be complemented using Blockchain [2] to improve privacy, reliability, and security [3].

MANET is a standalone network, and communication is restricted to the nodes' transmission coverage area. To increase its connectivity and its application scope, however, MANET can be connected to the IP network, forming a hybrid MANET. The integration of MANET with the IP network provides many advantages for both networks. The integration reduces communication and deployment costs and helps to extend the coverage of the existing infrastructure. It also provides additional services for the MANET. The integration provides MANET nodes with internet access, and thus increases the application scope for MANET. This would then allow MANET users to access web services that are not available in the traditional stand-alone MANET. Moreover, the recent development in the cellular network technology enhances the feasibility of integrating MANET with the Internet. Fifth-generation 5G technology, for example, comes with its merit of increased bandwidth and reduced delay, which ease the integration of ad hoc networks and IP networks [4][5][6].

MANET networks and IP networks were originally designed for different environments and use different setup and routing protocols. Due to the inconsistency between the two architectures, gateway nodes have been used to ease integration, acting as interfaces between the heterogeneous networks. Integrating these networks undoubtedly raises many challenges and issues. Gateway discovery, gateway selection, quality of services, load balancing, security, and mobility management are the main issues when connecting MANET to the internet.

Traditional mobility management protocols provide seamless mobility in single hop wired infrastructure. Mobile nodes can thus maintain their global connectivity without interrupting ongoing sessions. Mobility management becomes more challenging, however, in a network that relies on multi-hop communication, such as MANET. The topology change in a MANET–internet integrated network is not caused by the source and destination nodes mobility alone but can also occur when intermediate nodes along the path used change their location. A mobility management system therefore plays a key role when integrating MANET with the internet to support the mobility and connectivity of MANET nodes.

A number of MANET–internet integration surveys have been published in recent years. Some are more general and cover any integration proposals without paying attention to a particular challenge [7][8]. Others have a different focus with respect to the ad hoc network technology, such as focusing on Wireless Sensor Networks based on 6LoWPAN Technology [9][10] or vehicular networks [11]. More similar surveys to that presented in this paper were published more than 10 years ago [12], however, a large number of solutions have been proposed since then. It is thus necessary for a renewed look at recent solutions.

2. MANET Routing Protocols

MANET is defined as a set of mobile devices that can communicate with each other using radio channels. It does not require an existing infrastructure to operate. MANET is a dynamic network where mobile devices can freely move, causing disruption and inconsistency in the network. Moreover, MANET is a self-configured network that does not require centralized components for its management. Mobile devices can organize themselves and cooperate with each other to guide network packets to their final destinations. A MANET node plays the role of both an end system and a routing router.

There are several surveys of MANET routing in the literature. The most recent surveys concentrate on particular MANET aspects, such as power efficient routing [13], hybrid routing mechanisms [14], congestion awareness and adaptive routing [15], or ant colony-based routing [16]. A comprehensive and detailed survey was published by Alotaibi and Mukerjee [17], however, for the purpose of this paper, the focus is only on the major classification of MANET routing. For a more detailed review, please refer to the above-mentioned papers.

MANET routing can generally be classified into reactive and proactive routing; however, these can be further divided to include categories such as hybrid routing, hierarchical approaches, geographical systems, multi-path, multicast, and geocast categories [18]. Reactive and proactive routing, AODV and DSDV, respectively, are the most commonly used routing systems when integrating MANET with the internet. Therefore, the AODV and DSDV are

introduced as representative for the reactive and proactive routing in the following subsections. Figure 1 shows the adopted taxonomy for MANET routing categories in this entry.

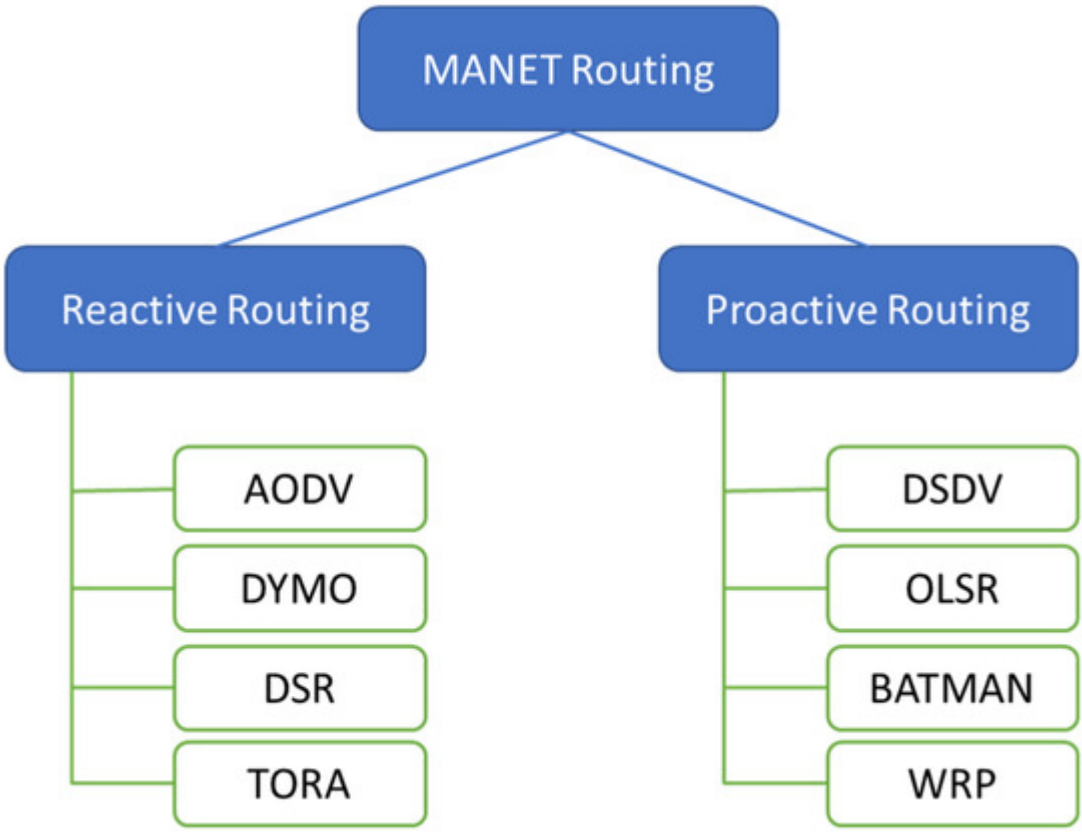

Figure 1. Taxonomy of Mobile ad hoc Network (MANET) routing protocols.

3. Conclusions

Mobility management in single-hop infrastructure networks is provided using traditional mobility management protocols, however it is more challenging when applied to multi-hop and infrastructureless networks such as MANET. This paper surveys the existing efforts in the literature to provide mobility management solutions for MANET integrated with the internet.

Despite the fact that many solutions have been proposed, there are still many open research issues that need to be further investigated, such as the quality of service based on the MANET application priority when managing mobility handover, optimizing solicitations and gateway advertisement control overheads, and investigating the feasibility of other MANET underlays such as OLSR and BATMAN to better meet the needs of an integrated network.

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