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A Review on Auto-Configuration Protocols in Mobile Ad Hoc Networks

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Abstract: ***Ad-Hoc networks are the wireless network without infrastructure. MANET's are special kind of wireless networks with no centralized control. They consist of mobile platforms which are free to move arbitrarily. The existing Internet topology has a router topology which is static in nature. In Mobile Ad-hoc network, the nodes are mobile and inter-node connectivity may change frequently during normal operation. A protocol is needed to perform the network configuration automatically and dynamically, which will use all nodes in the network or part of as if they were servers that manage addresses. This paper reviews various auto-configuration protocols and autonomous addressing protocols requiring a distributed and self-managed mechanism in order to avoid address collisions in a dynamic network with fading channels, frequent partitions and joining/leaving nodes. These protocols can be used to configure mobile ad-hoc nodes based on a distributed address database that will reduce the control overhead and also can be helped to overcome packet losses and network partitions.***

Keywords: Ad-hoc networks, Mobile Ad-hoc networks, auto-configuration protocol, address collision, network management.

1. Introduction

A mobile ad-hoc network is a self-configuring infrastructure. An auto-configuration protocol is designed to work in MANET that allows joining nodes to dynamically obtain addresses and efficiently manage addressing. It also handles merging and partitioning of networks. These routing protocols depend on nodes having a unique address. A dynamic scheme for assigning and managing addresses is discussed in this paper. In such schemes, nodes require a unique address for packets to be delivered to the correct destination. But sometimes, side effects due to routing arise from nodes using duplicate addresses. It is said that hosts use IPv4 or IPv6 addresses in fixed-IP based networks which have a hierarchical element to their structure. There are 2 purposes of an IP address- to identify the node and to encode routing information. Encoding of routing information plays a very important role when the nodes are mobile. Again, there are two ways to handle this mobility. Dynamic Host Configuration Protocol uses servers to auto-configure nodes with a topologically correct address as they move. Mobile IP allows nodes to maintain a static identity based on the home address, so a node is always contactable via a static address. But a problem arises practically as there may be no infrastructure available. DHCP always rely on an address server. But it is unable to provide a solution to the addressing problem by DHCP. Addresses are used as a means of identification within the ad-hoc network, and so must be unique within the network. Instead of this, ad-hoc routing protocol handles the routing by using a flat address space. For solution of this problem, each node is provided with a permanent unique identifier that could be used to identify the node within the MANET [1].

MANET is a set of mobile nodes that communicates between themselves through wireless links. In this, nodes rely on each other to operate themselves by using multi-hop communication. For this, the ad-hoc nodes need to configure their interfaces with the local addresses which are valid within the ad-hoc network. They may also need to set global routing addresses to communicate with other devices on the Internet. Thus, an ad hoc network presents itself as a multi-hop level 3 network which is constituted by a collection of links [2].

A network protocol may affect the entire network performance of MANET. Addressing is a vital step for MANET nodes to communicate with each other. Address auto configuration schemes based on communication models are also discussed in this paper. These schemes include the centralized and distributed schemes. The centralized scheme says that a node will be a server node acting as DHCP server and a new node should communicate with the server node to get an address. While in distributed scheme, every node must communicate with each other to get an address [4].

2. Auto-Configuration in MANET

The TCP/IP protocol allows the different nodes from the network to communicate. This is done by associating a distinct IP address to each node of the same network. There is a server or node which assigns these IP addresses in wired or wireless networks with an infrastructure. But in Mobile ad-hoc networks, some protocol is needed to perform this function due to lack of centralized entity. This protocol performs the network configuration in a dynamic and automatic way, which utilizes all the nodes of the network or a part of it, as if they were servers that manage IP addresses. Due to dynamic technology of mobile ad hoc networks constant movement of the nodes that can join and leave the network frequently and simultaneously. Auto configuration protocols are faced with various problems that guarantee the

uniqueness of IP addresses and allows network partitioning and merging. It is said that, to guarantee the correct functioning of the network, the protocols should achieve some objectives. These objectives include assigning unique IP addresses, functioning correctly, fix the problems derived from the loss of messages, allow the multi-hop routing, minimizing the additional packet traffic in the network, verify the existence of competing petitions for an IP address and conduct synchronization [2].

Address assignment is an issue in ad hoc networks due to self-organized nature. Centralized mechanisms such as DHCP or the Network Address Translation (NAT) conflicts with the distributed nature of ad-hoc networks and do not address network partitioning and merging. Filter based addressing protocol is the protocol that maintains a distributed database stored in filters containing the currently allocated addresses in a compact form. Bloom filter and a proposed filter called as sequence filter is designed to form a filter-based protocol that will assure the univocal address configuration of the nodes joining the network and the detection of address collisions after merging partitions. Every node easily checks whether an address is already assigned or not. The use of hash of this filter as a partition identifier provides an important feature for an easy detection of network partitions [7].

Address configuration acts as an essential phase before the communication of network nodes. This issue was dealt by Dynamic Host Configuration Protocol i.e. DHCP and the dynamic configuration of IPv4 Link-Local Addresses. For Ad-hoc networks, DHCP is too centralized for such a dynamic environment and IPv4LLA assumes a local broadcast network. This is the reason why new address autoconfiguration approaches must be adopted for AD-hoc networks. Any address autoconfiguration mechanism should address some requirements like change in topology i.e. nodes could join and leave the network at any moment without notification; network partitioning and merging. An ad-hoc network anytime could be divided into two or more disconnected networks. These partitions or other mobile networks could remerge later on. The autoconfiguration protocol should be able to deal with these situations and the resulting address conflicts or address leaks [3].

3. Auto-Configuration Schemes

3.1 Auto-configuration Protocols

The autoconfiguration protocols are classified according to address management. They are Stateful, Stateless and Hybrid Protocols. In Stateful, the nodes know the network state i.e. they keep tables with the IP addresses of the nodes. Stateless scheme consists of the IP address of a node which is managed by itself. They create a random address and perform a process of duplicated address detection steps to verify their uniqueness. Lastly, the Hybrid Protocols mix mechanisms from the previous ones to improve the scalability and reliability of the autoconfiguration. The algorithms present in this have a high level of complexity [2].

Stateful Protocols

MANETConf is based on existence of a common distributed table so that all the nodes are able to assign IP addresses. When a node wants to join the network, it sends broadcast messages to other nodes and the first one which replies to the message, chooses it as an initiator node and it can supply an IP address.

DAAP (Dynamic Address Allocation Protocol) is based on the concept of address assignment by a leader. The leader functionality is shared among all network nodes. When a new node joins the network, it becomes the leader until the next node joins. The leader maintains the highest IP address within the ad-hoc network and a unique identifier is associated with the network.

D2HCP (Distributed Dynamic Host Configuration Protocol) is an auto-configuration protocol for mobile ad hoc networks which guarantee the uniqueness of IP addresses used in the network. The protocol makes the nodes of a MANET work together to manage the unique and correct IP address assignment in a distributed manner. All network nodes have the same role; there is no special node type that centralizes the management. The protocol is based on the OLSR routing protocol to perform synchronization. This further helps to detect changes in the network.

Stateless Protocols

DAD (Duplicate Address Detection) is a process that is used to check how much uniqueness is present in IP addresses. It takes a long time to complete the same. There are three kinds of DAD processes as SDAD (Strong Duplicate Address Detection), WDAD (Weak Duplicate Address Detection), and PDAD (Passive Duplicate Address Detection).

Strong DAD

It is the base of the Stateless protocols and consists of a very simple mechanism where the node chooses two IP addresses-temporary and tentative. For initialization, it uses temporary address while it detects if the tentative one is unique or not. A message ICMP is sent directly to this address for the purpose of detection. If it receives a response, this IP address is being used so as to resume the process. And if it does not receive a response, the message will be sent a certain number of times to make sure that the address is unique.

Weak DAD

This has the idea of bearing the duplicated address in the network for a period of time. Thus, every node when is being initiated by itself, will create a key which will always be sent along with its IP address. Whenever a node receives a message, it will check whether this IP address is already assigned in its table and further will look whether the keys coincide. If the keys do not coincide, it will mark that address as invalid and at last actions will be taken so that they are unique. This whole process has to support the identification of a node by means of a key-IP pair and it completely depends on the routing protocol.

Passive DAD

This concept is based on sending control information instead of detecting or solving duplicated IP addresses. Every node is

investigated to deduce whether a duplicated address exists by events that would never happen if all the IP addresses were unique. For correct functioning of the detection. Three passive detections are proposed which are sequence numbers, locality principle and neighborhood.

Hybrid Protocols

The first hybrid auto-configuration protocol was HCQA (Hybrid Centralized Query-based Autoconfiguration). A node that wants to join the network undergoes a SDAD process. If the process is successful, the node will have to register its tentative IP address with an Address Authority. To do this, it will expect a message from the Address Authority and when that message has been received, it will send a registry request and the Address Authority will confirm it.

PACMAN (Passive Autoconfiguration for Mobile ad hoc networks) is a passive auto-configuration protocol for MANET. It uses elements from stateless and Stateful protocols, so it could be considered as hybrid. Its operation is based on each node assigning itself an address when joining the network, and passive monitoring of communications for the detection of duplicate address. The information is shared among different network layers so as to achieve minimum overhead in the communications. PACMAN uses the PDAD process to monitor the communications in order to search the duplicate addresses.

3.2 FAP (Filter-based Addressing Protocol)

FAP maintains a distributed database stored in filters that contain the currently allocated addresses in a compact form. This protocol has an aim to dynamically auto-configure network addresses which further leads to resolve collisions with a low control load, even in joining or merging events. In order to achieve all these objectives, FAP uses a distributed compact filter to represent the current set of allocated addresses. This filter is present at every node so as to simplify frequent node joining events and reduce the control overhead that is required to solve address collisions inherent in random assignments. The other important thing is the filter signature which easily detects network merging events, in which address conflicts may occur. In FAP, two filters depending on the scenario can be used. They are; the Bloom filter, which is based on hash functions, and the Sequence filter, which compresses data based on the address sequence [7].

Procedure of FAP

- Network Initialization
  It deals with the auto-configuration of the initial set of nodes. There are two different scenarios that can happen at the initialization step: the joining nodes arrive at one after the other with a long interval between them and is termed as gradual initialization, or all the nodes arrive at the same time which is termed as abrupt initialization. The Hello message is used by a node to advertise its current association status and partition identifier. The AREQ message is used to advertise that a previously available address is now allocated.
- Node Ingress and Network Merging Events
  After the initialization, each node starts broadcasting periodic Hello messages. These Hello messages contain its address filter signature. When a Hello message is received, neighbors evaluate whether the signature in the message is the same as its own in order to detect merging events.
- Node Departure
  When a node leaves the network, its address should become available for other nodes. If the departing node is correctly shut down, it floods the network with a notification to remove its address from the address filter. Therefore, every node in it verifies the fraction in their address filters every time the filter is updated.

4. Conclusion

We studied the auto-configuration mechanism that provides a dynamic protocol for mobile ad-hoc nodes and allows the creation of a self-organizing network. We also studied that address auto-configuration protocols are classified by the way they maintain the available addresses. The further study of how efficiently the FAP protocol can be used to resolve the address collisions in Mobile Ad-Hoc networks is possible.

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