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QoS Provisioning in VANETs using Mobile Agent

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ABSTRACT

Due to the bandwidth limitation and vibrant topology of VANETS, supporting Quality of Service (QoS) in VANETs is a challenging task. Mobile agents are used to reduce the communication cost, especially over low bandwidth links, by moving the processing function to the data rather than bringing the data to a central processor. The aim of this paper is to propose a framework for providing QoS in VANETs. The proposed framework uses local information of nodes such as node's speed, buffer, and power to select path for routing.

1. INTRODUCTION

QoS provisioning often requires negotiation between host and network, call admission control, resource reservation, and priority scheduling of packets. QoS can be rendered in network through several ways, viz., per flow, per link, or per node. In network, the boundary between the service provider (network) and the user (host) is not defined clearly, thus making it essential to have better coordination among the hosts to achieve QoS. Characteristics of network such as lack of central coordination, mobility of hosts, and limited availability of resources make QoS provisioning very challenging. [6].

2. ISSUES AND CHALLENGES IN PROVIDING QOS

Providing QoS support in ad-hoc network is a dynamic research area. Network has certain inimitable characteristics that facade several intricacy in provisioning QoS. How the characteristics of network affect QoS provisioning is given below:

- *Dynamically Varying Network Topology:* Since the nodes in an ad hoc wireless network do not have any restriction on mobility, the network topology changes dynamically. Hence the admitted QoS sessions may suffer due to frequent path breaks, thereby requiring such sessions to be re-established over new paths.
- *Inaccurate State Information:* In most cases, the nodes in an ad hoc wireless network maintain both the link-specific state information and flow-specific state information. The link-specific state information includes bandwidth, delay, delay jitter, loss rate, error rate, stability, cost, and distance values for each link. The flow specific information includes session ID, source address, destination address, and QoS requirements of the flow (such as maximum bandwidth requirement, minimum bandwidth requirement, maximum delay, and maximum delay jitter). Hence routing decisions may not be accurate, resulting in some of the real-time packets missing their deadlines.
- *Lack of Central Coordination:* Unlike wireless LANs and cellular networks, ad-hoc networks do not have central controllers to coordinate the activity of nodes. This further complicates QoS provisioning in network.
- *Error Prone Shared Radio Channel:* The radio channel is a broadcast medium by nature. During propagation through the wireless medium the radio waves suffer from several impairments such as attenuation, multi-path propagation, and interference (from other wireless devices operating in the vicinity).
- *Hidden Terminal Problem:* The hidden terminal problem is inherent in network. This problem occurs when packets originating from two or more sender nodes, which are not within the direct transmission range of each other, collide at a common receiver node.
- *Limited Resource Availability:* Resources such as bandwidth, battery life, storage space, and processing capability are limited in network.
- *Insecure Medium:* Due to the broadcast nature of the wireless medium, communication through a wireless channel is highly insecure. Hence security is an important issue in network, especially for military and tactical applications. Networks are susceptible to attacks such as eavesdropping, spoofing, denial of service,

message distortion, and impersonation. Without sophisticated security mechanisms, it is very difficult to provide secure communication guarantees. [6]

3. QOS MANAGEMENT USING MOBILE AGENT

Quality of service (QoS) management parameters such as guaranteed bandwidth, bounded network delay, bound delay jitters and sustainable packet losses are essential for facilitating multimedia services in a network. A typical QoS architecture should support the following: configuration, prediction, and management of QoS at all the levels of abstraction (user, system and network level); management, control, and processing of a flow must be distinct activities; application must be transparent from establishment and management; asynchronous resource management of different components; and performance enhancement. An agent based QoS architecture do supports all these features. [6]

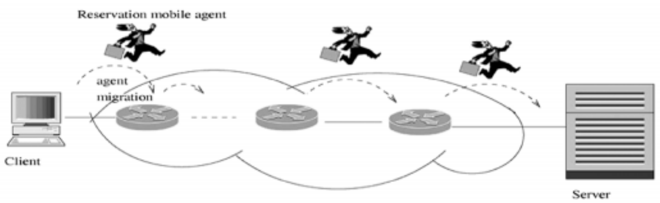

Fig 1: Agent based QoS Management

QoS offers flexibility, scalability, efficiency, adaptability, software reusability and maintainability. Agent-based schemes comprising of static or mobile agents offer several advantages as compared with traditional approaches: reduced latency, works in heterogeneous environment, reduced network traffic, encapsulates protocols, flexibility, adaptability, software reusability and maintainability, and facilitates the creation of customised dynamic software architectures [1-3]. However, mobile agent technology is still in its infancy and has certain problems that have to be resolved. Even though it is difficult to quantify these features, we explain how QoS is achieved through mobile agents.

- *Flexibility:* The agents allow learning capabilities to be integrated in a natural way to support delay predictions, bandwidth predictions, and play out decision-making based on the host architecture and network loads. For example, a QoS mobile agent can be encoded with some intellect to trade the resources along the route depending on the user or service provider requirements. Flexibility can also be seen in providing the mobile agent code for personalising the services of the users. For example, a mobile agent can make provision to take into account of cumulative connections from a client to compute a QoS path or to negotiate the network resources in an optimal way.
- *Reusability:* Mobile Agent software can be reused by different types of multimedia applications by making slight modifications to the software. It is possible because of autonomous operation of the agents in agent-based systems. For example, an application may reuse the mobile agent for QoS in routing to collect the network management parameters from second/third degree neighbours of the visited nodes.
- *Maintainability:* The software can be easily maintained since every agent of an agent-based system is developed on a modular approach. Debugging and updating of the mobile agent software can be done with ease.
- *Adaptability:* Mobile agent can easily adapt the rapid changes in the network conditions (congestion/failure) and user requirements. For example, a mobile agent dynamically computes the QoS routes as and when required (either due to congestion or link problems or user requirements).
- *Efficiency:* The use of a mobile agent increases network resource utilisation efficiency because of its adaptability to network and user requirements and exchange of minimal information during task execution and decision making with multiple resource information.
- *Scalability:* The scalability can be achieved by using the mobile agent at a client to execute similar tasks of several users. The scheme uses only certain degree neighbour's information to compute the multiple paths. Thus the scheme is scalable.

4. MOBILE AGENTS IN VANET

As we know, Vehicular traffic is a major problem in modern cities. We collectively waste huge amounts of time and resources while travelling through traffic congestion. Significant savings of fuel and time could be achieved if traffic control mechanism could be effectively discovered. For these problems we used VANET: An ad hoc network formed by the vehicles in a local area is known as a Vehicular Ad Hoc Network (VANET), enables vehicles to directly communicate and inform each other of their local situation. For example, a vehicle recognizing a traffic jam or a hazard on the road can use the VANET to inform approaching vehicles. Based on the information received via the wireless link, driver assistance systems are able to warn the driver or adapt the route to the destination accordingly. By ad hoc communication, a driver is aware of the traffic conditions in an area significantly exceeding the range of human perception or automotive sensors installed in the vehicle. Furthermore, data received from access points at the roadside, e.g. at gas stations, can be exchanged via VANET and allow the driver to get up to date travel information such as gas prices or tourist news. In contrast to existing cellular networks, no infrastructure is required and communication is provided free of charge. And due to the direct information exchange between vehicles, telemetric services in the VANET can provide information with lower delay and a higher level of detail for the local area compared to existing solutions such as the public radio systems. While the application of ad hoc communication between vehicles is therefore very attractive, several challenges remain. The mechanisms applied in conventional ad hoc networks are developed for low mobility of individual nodes and a relatively stable resulting network topology. In contrast, VANET are characterized by a highly dynamic topology due to the high relative velocities of vehicles and specific movement patterns.

Vehicular Ad hoc Networks (VANETs), also called Vehicle to Vehicle Communication (V2VC) or Inter-Vehicle Communication (IVC) networks can be considered as a specific case of traditional MANETs. In VANETs, the mobile nodes are vehicles, and because of their high mobility and speed, the main VANET disadvantage is that the network topology changes frequently and very fast. On the contrary, in VANETs vehicles move only on predetermined roads, and they do not have the problem of resources limitation in terms of data storage and power. Furthermore, we can assume that it is always possible for a vehicle to obtain its geographic position by using GPS, which can provide good time synchronization through the network as well. [7]

There is a growing need for the improvement of the efficiency of traffic in order to ensure the sustainability of modern cities. With the existing vehicular traffic control systems following transportation needs or issues are identified: [7]

- Deficiency of real-time traffic information.
- Deficiency of access to travel information and 24 hour real-time alternate route information.
- Enhanced alternate route supervision.
- Deficiency of readily available transit information to increase ridership.

To solve these issues we will use mobile agents in VANETs. In our technique, we propose an intelligent agent based VANET. In this aspect we will study five types of agents in VANET:

1. Routing Agent;
2. Mobile Agent;
3. Inside Vehicular Agent;
4. Alerting Agent;
5. Information sighting Agent.

All vehicles moving in the network considered to be part of the network for traffic monitoring and control. The core of the system is creation of mobile agent of intelligent nodes. Agents are static nodes placed at intersections and along the streets, which maintains the database of traffic information and routing information. Road side sensors monitor the traffic situation and it is provided to nearby Agents.

The network consists of mobile nodes in an ad-hoc environment. The Mobile Agent (MA) are strategically placed such that MA is well connected to at least one neighboring MA. Desirable characteristics of MA node are:

- Processing power to sustain distribution of database and node management.
- More than average normalized link capacity.
- MA to MA and MA to mobile node connectivity and reliability.
- Large buffer capacity to maintain ubiquitous database and routing table.

RAs are responsible for route discovery, route maintenance and distribution of omnipresent database. Mobile agent keeps the route information and presence information. Each RA finds the path to neighboring RAs using MAs. MAs collect network behavior information which contain dynamic behavior of network resources like bandwidth and buffer availability at a node and pass it to a RA. The next task is to form routing table at RA node. To form routing table, paths from a RA node to its neighbors are established. Path discovery is carried out by MAs. A RA node sends Advance Mobile Agents (AMAs) in network to discover the paths between itself and neighboring RAs. Since any RA node can be connected to nearest RA node within maximal number of hops. This avoids flooding. Between each pair of RA node, many paths are discovered and all paths are recorded in routing table. After receiving AMA, RA node generates Reverse Mobile Agent (RMA). Algorithm 1 explains working of AMA.

Algorithm 1: Advance Mobile Agent (AMA)

Step 1: Move RA into network & count nodes.

Step 2: If (hop == 1) then,

Step 3: Mobile agent is deleted (because no other node is there.)

Step 4: else

Step 5: If RA node reached to next node then, Convey all the collected information to RA, i.e., information regarding path followed and resources available on that path.

Step 6: Create Reverse Mobile Agent with path information.

Step 7: else

Step 8: Decrease the hop of mobile agent by 1.

Step 9: Collect the network information needed for routing & submerge the mobile agents to neighbor nodes.

Step 10: end if

Working of RMA is explained in Algorithm 2.

Algorithm 2: Reverse Mobile Agent (RMA)

Step 1: if RA node reached to next node then

Step 2: Convey all the collected information to RA, i.e., information regarding path followed and resources available on that path to update routing table.

Step 3: remove mobile agent.

Step 4: else

Step 5: give all the information collected to node.

Step 6: travel to next hop.

Step 7: end if

Inside Vehicle Agent (IVA): IVA is static agent resides in vehicle which communicates with the RA to acquire/ spread the relevant information. IVA collects the status (moving or stationary) and location information of vehicle from sensors equipped in a vehicle.

Alerting Agent (AA): AA is a mobile agent that travels around the network by creating its clones to propagate the decisive information during the critical situations. Examples of critical situation are accident, traffic jam, bad weather conditions, tracing a vehicle involved in crime or traffic rule violation etc. It also informs IVA and updates the vehicle database. AA is sent by RAs to the vehicles moving in the network.

Information sighting Agent (ISA): ISA travels in the network to search for the requisite information as desired by vehicle user. ISA is sent by the RA in the network on the request issued by user or RA itself to get traffic information. [8]

5. CONCLUSION

A key concern of our work is to preserve the desired QoS of applications in mobile environments without introducing considerable overhead. The basic idea of the mobile agent based systems is to distribute the management functionality throughout the network, to manage rapid changes and the scalability of VANETs complex and heterogeneous networks.

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