Towards Suitable Communication Protocols For Mobile Multiplayer Games on Heterogeneous Mobile Devices

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Abstract

Currently research into communication protocols with regards to multiplayer gaming requirements has been sparse. There are a number of surveys on multicasting in mobile device communication which addresses latency reduction, density and traffic. Moreover, these studies have not addressed multiplayer gaming issues. Recent research in the area of mobile devices has focused in mobile communication and distribution systems for homogeneous devices but they have not fully addressed communication between heterogeneous devices. This work investigates suitable communication protocols for mobile multiplayer games on heterogeneous mobile devices. In particular issues such as scalability, reliability, bandwidth and data transportation time of communication systems and content distribution of mobile heterogeneous devices will be addressed. This paper proposes a hybrid protocol solution that addresses communication issues related to heterogeneous mobile devices as existing MANET protocols seem to lack the capability of solving these issues collectively.

1.0 Introduction

Mobile Ad-hoc Network (MANET) is a complex distributed system that can dynamically self-organise into an arbitrary ad-hoc network topology allowing mobile devices to communicate without pre-existing infrastructure [1]. The devices in a MANET must be able to function as routers for data transmission among themselves. In multiplayer gaming, messages are sent between devices and from a central server to other devices. This highlights the need for a multicasting as opposed to multiple unicasting for state information and message distribution in multiplayer mobile gaming. There are several multicast protocols designed to counter
a number of major issues with regards to mobile adhoc network communication. Some of these protocols include:
the PMRP which looks mainly at power awareness of different devices in the network [2], MAODV [3] which uses on demand route materialising protocol, and HTMRP [1] combines group multicast and hypercube features providing scalability, high availability and good load balancing in MANETs. The need to exchange state information with low latency and the ability to adapt content to suit different device graphic capabilities are some of the main issues in mobile multiplayer gaming. Despite the fact that there are many protocols which offer good awareness on device capabilities, increased reliability and network availability, scalability and distributed loads but it seems difficult to identify the right protocol that would be suited for multiplayer mobile games on heterogeneous devices [4]. It is therefore necessary to develop a communication framework that would satisfy the requirements for multiplayer games on heterogeneous mobile devices. This paper is divided as follows: section 2 looks at MANET routing and simulation tools, section 3 looks at MANET Issues in Multiplayer gaming on mobile devices while section 4 summarises the paper and details the design of a new solution which is to be researched into and developed while the last section concludes the paper and highlights the next step in our research work.

2.0 MANET Routing

The routing protocol is the one that actually looks for ways and means of transporting the data from source to destination in the fastest and most cost effective way possible. In Adhoc networking, a fast and adaptive protocol which uses predefined bandwidth for data transmission is required [5]. Therefore the main characteristics for a gaming MANET routing protocol would be adaptability, reliability, power awareness, scalability, security and low overhead [5]. These are important requirements in designing a protocol for mobile multiplayer gaming purposes.

There currently are three types of routing protocols in adhoc networks namely reactive, proactive and Hybrid. The proactive routing entails the exchange of routing information between nodes periodically maintaining a complete and consistent overall view of the topology at all times. This allows the nodes to use this information to calculate costs of reaching all possible destinations [5]. There are sub-divisions of this type of routing that include distance vector routing and link-state algorithms. As its name suggests with distance vector the node maintains a vector which contains a distance to all nodes and broadcasts this vector to its neighbours periodically. It continually updates its routing table with calculations of shortest

paths to the different nodes using information received from its neighbours. While in link-state routing, each node can keep and maintain states of its links to its neighbours and broadcasts this information to other nodes [5]. The main advantage of proactive routing is that it does not suffer from initial delay when a routing path is needed. Proactive routing however have high overhead and longer route convergence time especially when high mobility patterns are brought into the scene.
Reactive routing involves route discovery as and when needed for delivery of packets to a destination node/nodes. The route information is then kept for the duration of the communication instance. This causes significant delays that might be encountered in a route which is being sourced. It offers good resources management by disabling inactive routes and not exchanging of routing information periodically.
There is another form of routing which involves the use of both routing types which is called hybrid approach, an example of which can be seen in Zone Routing Protocol (ZRP) [5]. This approach brings about more robust routes and fewer control messages though there may be a requirement of some periodical messages to maintain the clusters. They do tend to involve centralization of nodes and this brings about single points of failure in the resultant MANET [5].

3.0 MANET Issues in Multiplayer mobile gaming

Multi-player mobile gaming involves the cohabiting of more than one user playing against one another or as a team. This normally could involve 10's of players to literally thousands. There are however various constraints that have cropped up with the making of multiplayer games for mobile devices including latency, bandwidth, hardware limitations, graphics etc. There are some needs with regards to casual mobile gamer which do tend to appear when one looks at the big picture of multiplayer gaming on mobile devices. These are not necessarily issues but specificities that would actually go a long way in promoting multiplayer gaming to mobile device users. Some of these include ability of the gamer to join and leave gaming sessions at will without hassle and in the shortest time possible which does boil down to smooth hand- offs. As shown by the experimental work by Kwan-Wu Chin etal [6]. One observation was that while in cellular networks signal to noise ratio was monitored between phone and base station to determine when to hand off from one base station to another, this form of prediction is not available in MANET protocols. Although DSDV [6] a proactive MANET routing protocol seems to handle the exchange pretty well with smooth hand-offs during experimentation. Its route stability deems to be better than AODV a reactive routing protocol [6]. Another important issue involves the exchange of game state information between different users of multiplayer gaming that can only be achieved when a reliable network is in place. Reliability in MANET's is not always achievable due to different aspects including mobility of nodes, interference etc. Implementation experiments, using Proactive and reactive routing MANET protocols, show both protocols failing due to their inability to sieve through reliable one hop neighbours and unreliable ones [6]. Another issue needs to be addressed is the awareness of power levels of different devices on the network to establish which nodes to use during transport of data. This can be seen with the MANET protocol PMRP [2].
Hybrid routing encompasses the positives of both types of routing with proactive operations being restricted to a small domain in order to reduce the control overheads and delays. The reactive routing protocols are used for locating nodes outside this domain that is more bandwidth-efficient in a constantly changing network [7]. An example of the above mentioned hybrid protocol is the ZRP [9] which has the ability to not directly conflict or compete with any of the protocols but takes advantage of each of those protocols strengths, depending on the situation, requirements and implementation. It does tend to have a few issues mainly power consumption and bandwidth utilisation tackled by Arun [10] where he proposes a new method for reducing power consumption in ZRP by creating specific power zones thus limiting the amount of power used to broadcast a message. Genetic algorithm and fuzzy logic have also been an area of interest with regards to MANETS and have thus produced a few routing protocols which encompass use of genetic algorithms to support MANET routing thus providing a protocols that learn and adapt to mobility of nodes [18]. Some examples of genetic algorithm routing protocols include CEDAR [20] a core extraction distributed adhoc routing protocol for small to medium sized adhoc networks, ticket based algorithm by Chen and Nahrstedt [21], NEST by Barolli L. etal. [22] which used two Quality of service parameters to enable the algorithm to calculate and generate robust routes sacrificing on optimality of routes. Another example also looks at energy efficiency in MANETS thus uses genetic algorithm for the purpose of creating an energy saving algorithm. This algorithm DMEM (distributed minimum energy multicast) looks at reducing the amount of RF energy required by multicast communication for MANETS. This has however been hampered with the fact that most of these use few QoS parameters as points of review to find best paths and thus do tend to look at reliability of routes and bandwidth in some cases.

4.0 Future communication protocols for mobile devices

Current protocols discussed in earlier sections of the paper do not encompass all the features and requirements need for a multiplayer heterogeneous mobile device gaming. There is thus a need to develop

a protocol that encompasses reliability and awareness and have the following features:
a) a hybrid routing algorithm in the protocol application layer and genetic algorithm in network layer. b) use of zones to identify nodes that can be used in route computation. c) Genetic Algorithm would search the different zones to analyse and come up with routes which would be ranked. The rankings will be from 1 onwards with the first being the best the rest would be kept as backup routes. d) power awareness, device capabilities, bandwidth availability, node reliability when searching for new routes. e) a combination of hybrid routing algorithm and genetic search algorithm that would effectively extract the best topology of a MANET by avoiding redundant and unreliable links and other terminal problems.

This protocol will be implemented around the network and application layer while the MAC layer remains unchanged. Figure 1 shows the process flows in each layer and how these layers link with each other of the proposed protocol. The application layer is the top part of network structure where the protocol is to be implemented based on the principles of the hybrid mechanisms of ZRP [9] mentioned in the earlier parts of the paper. This layer has different modules that make up the full protocol. As the hybrid name suggests, it is made up of more than one protocol (IZP, EZP and BRP) as seen in Fig.1. These modules work together to provide routes dependent upon the sender nodes location and receiver nodes location and best routes nodes available. Thus the IZP comprises of InterZone node with each main node maintaining a table of its neighbours within its zone. The ExtraZone (EZP) uses the reactive routing elements to maintain routing outside the local zones by using local connectivity information monitored by the IZP. The BorderRouting protocol sends messages to the sender zone border nodes which look at their look-up tables to find out whether the receiver is part of their zones. When the receiver node is found a route will be established by taking into account the best routing nodes available from sender to receiver using information from the genetic algorithm available in the network topology.

The network layer is where the topology of a MANET is realised and it is within this topology the message routes for sending messages from source to destination node can be implemented. The Genetic algorithm (GA) is used in this layer so that it can aid in selection of the best routing paths for use during packet transmission from sender to receiver. The GA is given a list of potential suitable nodes that will then be filtered and built on during the genetic life cycle. An initial population of potential solutions will then be created as a starting point for the search. In the next stage, the performance (fitness) of each individual is evaluated taking into account the constraints imposed by the problem. Based on the fitness of each individual, a selection mechanism chooses "parents" for the crossover and mutation operators. The crossover operator takes two chromosomes and swaps part of their genetic information to produce new chromosomes. The mutation operator introduces new genetic structures in the population by randomly modifying some of genes, helping the search algorithm to escape from local optimum. The offspring produced are then added to the next population to be evaluated. GA can replace either a whole population or just its less fit members. The cycle repeats until a satisfactory solution to the problem is found, or some other termination criteria are met [13]. This is all decided with the aid of parameters that are used to generate a robust set of offspring (nodes) for use as nodes making up main inter-connectors between a sender node and a receiver node.

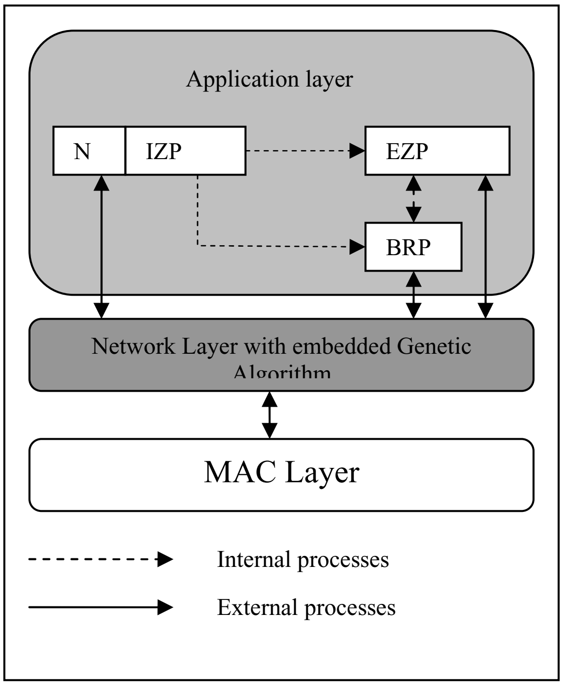

Figure 1 Proposed Protocol Layout

Conclusion

This paper discussed some of the networking issues related to multiplayer games on heterogeneous mobile devices and proposed a hybrid solution that addresses these communication issues. We presented several issues in MANETS that we are trying to address. Further, we discussed the use of genetic algorithms in the n and different types of protocols available that could be used in development of a network infrastructure suitable for mobile device multiplayer gaming. This would allow for selecting routing paths for game data and other information to circulate among heterogeneous mobile devices forming a MANET. Further evolution of the genetic algorithms and hybrid protocol would thus enable dynamic adaptation of the networking topology in line with different changes that occur in real time in MANETS. In future we plan to investigate the set of parameters that would form part of the algorithm and how weights are assigned to these. We plan to develop a prototype protocol that can be tested on heterogeneous mobile device multiplayer gaming. Future work includes analysis of the different simulation tools available for protocols to decide on the most appropriate one or even develop a new simulation tool which would be used to test the protocol and simulate scenarios.

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