Design and Implementation of Adaptive Communication Framework for Delay Tolerant Opportunistic Networks

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Abstract –

An opportunistic network is a subclass of Delay-Tolerant Network where communication opportunities (contacts) are intermittent, so an end-to-end path between the source and the destination may never exist. The link performance in an opportunistic network is typically highly variable or extreme. The transmission control protocol will perform badly in Oppnets because the end-to-end connection always needs to be reconstructed and data need to be retransmitted from the original sender again through the reconstructed connection. To solve this problem, the principles of on-time and at-one-time delivery is proposed, in which 'on-time' means to transmit data to the receiver during a pre-scheduled time period and 'at-one-time' means to transmit each piece of data from the sender just once. Based on the principles, the designed adaptive transmitting platform (ATPOO) supports the on-time and at-one-time delivering capacities in Oppnets. The transmitting process is divided into macro- and micro stages. The macro-stage deals with the end-to-end transmission quality of service; the micro-stage focuses on the transmission between adjacent nodes along with the pre-constructed delivering path. The proposed ATPOO based on the delay-tolerant network (DTN) architecture.

1. INTRODUCTION

The current Internet is composed of wired and wireless domains. Compared to wired domain wireless domain has many problems. Some application services and scenarios need kinds of ontime transmissions, in which the data need to be received at the proper time, means data cannot be received so early or so late for practical use.

An example is illustrated here for home healthcare. Let there be a patient or an elder who lives in a remote village, and a nursing home manager serves in a home care centre of a big city, which is responsible for monitoring many patients and elders using a smart phone.The daily routine is that the patient or the elder is required to measure the values of the health conditions, for example, ECG and EKG, within two time periods. The two suitable measuring time slots are (i) after waking up and (ii) before dinner. Then, the measured data need to be transmitted to the server located at the home care centre before the nursing home manager checks the data. Let the nursing home manager checks the data regularly at 10:30 and 20:00 through the smart phone. Furthermore, from the remote village to the city, the delivery path is composed of various network domains comprising Ethernet, 3G, WiFi, WiMax and WiFly. The measured data may need to be transmitted to the mobile phone of the nursing home manager using an on-time delivery manner. That is, these ECG and EKG data cannot be transmitted to a smart phone too early, for example, transmitting these data immediately after they have been measured, because the smart phone's memory currently stores others' data and is almost full. In contrast with early transmission, when the beginning time of transmitting is too late, that is, approaching the expected due time, the transmission needs to be finished in a short time period. This situation makes the burst transmitting rate, that is, high bandwidth requirement. The transmission may fail if the network congestion happens during the time period. Therefore they can be transmitted according to a schedule which can assure that these data can be received by the smart phone by 10:30 and 20:00 but will not be received too early.

In order to achieve the goal of on-time and at-one-time delivery guarantee two main transmitting principles are adopted. They are scheduling of available transmitting time and Store and forward transmission mechanisms.

1.1 Scheduling of available transmitting time

Data transmission should be scheduled in the on-time manner. Two characteristics of data transmission are as follows: (i) the delivery path from the source to the destination is through several network nodes and (ii) the bandwidth capacities between adjacent nodes are different.

1.2 Scheduled store and forward transmission

In order to avoid reinitializing the transmission procedure, which results in data's retransmission from the source again

(and again), the data should be transmitted using the hop-by-hop transmission method when a connection is broken. That is, the transmission does not need to be reinitialized from source to destination when the connection is broken in somewhere.

1.3 Opportunistic Network

An opportunistic network is a subclass of Delay-Tolerant Network where communication opportunities (contacts) are intermittent, so an end-to-end path between the source and the destination may never exist. The link performance in an opportunistic network is typically highly variable or extreme. Therefore, TCP/IP protocol will break in this kind of environment because an end-to-end path between the source and the destination may only exist for a brief and unpredictable period of time.

2. RELATED WORK

In the Opportunistic Network there does not exist a complete path from source to destination for most of the time. In addition, the path can be highly unstable and may change or break quickly. Therefore, in order to make communication possible in an opportunistic network, the intermediate nodes may take custody of data during the blackout and forward it when the connectivity resumes. So the main focuses here are the connection opportunity and the node storage capability.

Later CTDS is proposed its purpose is to accomplish reliable inter-community data transmission with less resource consumption. CDTS organizes all nodes into different communities based on the contact frequency between nodes. CDTS adaptively adjusts the number of data copies in the network and data can be transmitted to target community mainly relying on active nodes.

Malugo a peer-to-peer storage system where they have consider the problem of routing locality in peer-to-peer storage systems where peers store and exchange data among themselves. They have discussed that Malugo system, a peer-to-peer storage system that was designed for large-scale collaborative projects. The Malugo system can cluster peers by routing locality automatically, partitioning files to different peers to achieve load balancing and replicating files to different groups to achieve geographical properties.

In the vehicle routing problem the idea of the time scheduling is taken.. The objective is to find a set of delivery routes satisfying some requirements or constraints and giving minimal total cost on the basis of users' request. The focus of this work is that instead of transferring the data from source to destination directly it will transfer the data to destination via intermediate nodes. They will accept the data and transfer to the next node until it reaches the destination. Each intermediate node has a storage capacity to store and forward the data, each data has a predefined data for transmission. Each data is going to transfer on-time and at-one-time manner. It avoids the duplication of data.

3. PROBLEM STATEMENT

The main focuses on the traditional transmission are connection opportunity and node storage capability. The contacts between the nodes are scarcely predictable due to the node mobility. The main emphasis on the existing system is reducing the transmitting delay and increasing the delivery rate. The definition of the transmitting QoS model in opportunistic network is summarized as follows:

1. Each data follows a transmission principle of scheduled hop-by-hop message exchanging.
2. Each data has a predefined deadline for transmission.
3. Each node is provided with storage capacity.
4. Each data can be at-one-time and on-time transmitted.

In the proposed ATPOO two principles are proposed they are on-time and at-one-time delivery, in which 'on-time' means to transmit data to the receiver during a pre-scheduled time period and 'at-one-time' means to transmit each piece of data from the sender just once. Based on the principles, the designed adaptive transmitting platform (ATPOO) supports the on-time andat-one-time delivering capacities in Oppnets. In ATPOO,transmitting process is separated into macro-stage and micro-stages. The macro-stage deals with the end-to-end transmission quality of service, the micro-stage focuses on the transmission between adjacent nodes along with the pre-constructed delivering path.

The concept of the proposed transmission method can be observed through (i) macro-view and (ii) micro-view, which are depicted in fig 1.

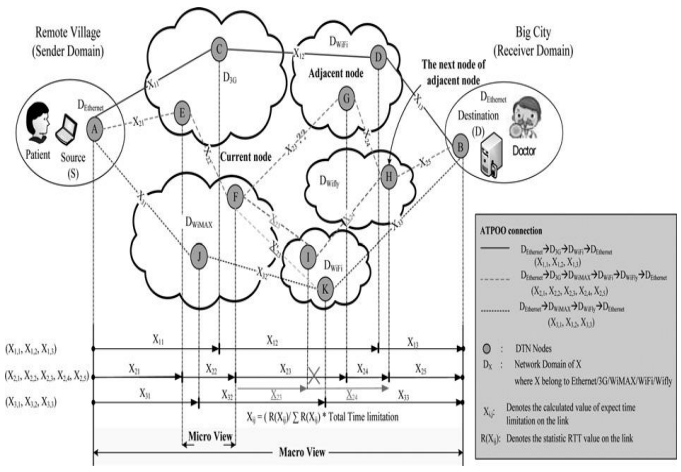

Figure 1 ATPOO Network Topology

(i) Macro-view: It refers to an end-to-end transmission method with a time limitation; that is, the proposed platform allows users to assign total expected delivery time of the data transmission from S to D. Furthermore, each segment is allocated distinct delivery time systematically based on round-trip time (RTT).

(ii) Micro-view: It acts as a monitor of the transmitting state in each segment. Means data transmission is hop-by-hop.

Based on the above two views, the macro-transmission (MaT) algorithm and the micro-transmission (MiT) algorithm are investigated. In the MaT algorithm the function of the minimum cost path is first developed, then the suitable delivery path can be obtained based on the function. Once the delivery path is selected, the reservation of the resources along this path is necessary. Finally, the system computes the arranged time of each segment so that the total expected delivery time can be properly allocated.

Furthermore, the MiT algorithm is proposed to establish the dynamic delivery strategies. That is, in order to ensure the effectiveness of at-one-time delivery, the designed strategies enable the multipath transmission policy to transmit data simultaneously, or trigger the path transfer mechanism. The aforementioned procedures are enabled based on the remaining data size and the current network state. It means that different selected delivery paths have different delivery sizes in the situation of multipath transmission.

The base for Macro-view and Micro-view is ATPOO initialization phase. This phase comprises 2 mechanisms they are transmitting model construction and resource monitoring. In the transmitting model construction, the system first allocates at least one DTN node in each network domain. Moreover, the link of any two adjacent DTN nodes is configured. After the ATPOO platform has been initialized and the link is created successfully, it starts the action of resource monitoring. The execution procedure is explained here.

(i)Information exchange: Any two adjacent nodes exchange information with each other periodically. The information is composed of the link's availability and node's loading capacity, which is called the ATPOO-maintained information profile(ATPOO-m) An ATPOO-m contains seven parameters.

Factors of link's availability include IP address A, ATPOO identifier S, RTT of the link (RTTmax, RTTmin and RTTavg), connectivity's probability of the link C and the rate of the on-time delivery of the link O.

Parameter S is used to distinguish the deployed ATPOO and the non-deployed ATPOO. Once ATPOO is installed on a node, the node becomes an available DTN node, and the parameter S is set as 1. Otherwise, S is set as 0. In addition, RTTmax/RTTmin/RTTavg represents the minimal/maximal/average speed of the delivery.

On the other hand, factors of node's loading capacity that needs to be taken into considerations are CPU's processing capability, memory size and buffer storage. Consequently, each DTN node maintains a network topology of its neighboring node to represent the network state around itself, including the loadings of neighboring nodes.

(ii) The supervision of resources: It requires a regular monitoring of the ATPOO. As the network state changes, its dynamic updates ATPOO-m, and the announcements of the variation are exchanged through neighboring links.

4. IMPLEMENTATION

The above explained Adaptive Communication Framework is implemented with the hardware equipments. Here 3 nodes are taken, one node acts as a sender, other as receiver and one more act as an adjacent node. All the three nodes will display the IP addresses to which they are connected.

Figure 2 Patient Module

This Patient node displays the IP addresses to which it is connected. And also it displays the IP address to which it send the data. If the destination will come in the one hop its IP address will appear in the ATPOO box, if the destination will come in the 2 hops its IP address will appear in 2-hop ATPOO.

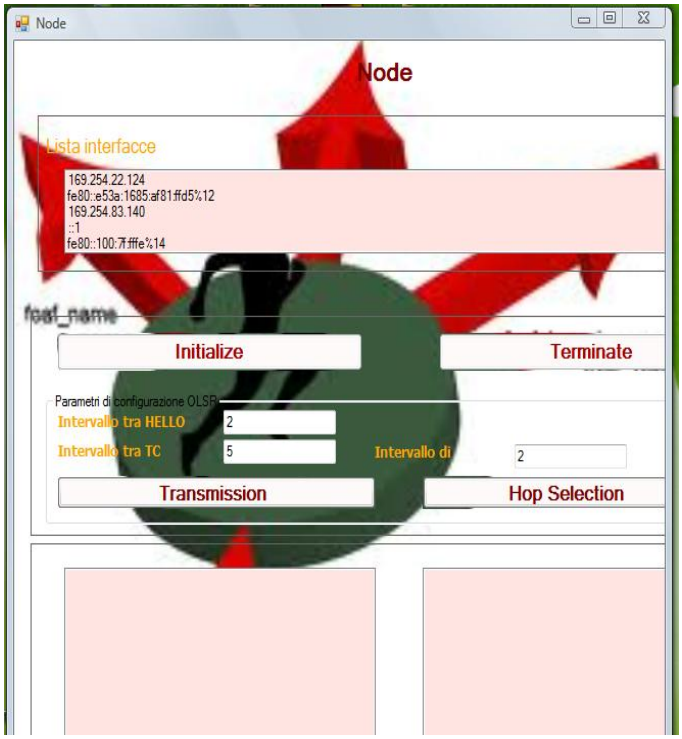

Figure 3 Adjacent Module

In this adjacent node module it also display the IP addresses of all the nodes to which it is connected. In the ATPOO box it will display the IP address of the nodes from which it receives the data. In the next box it will displays the IP addresses of the node to which it transform the data.

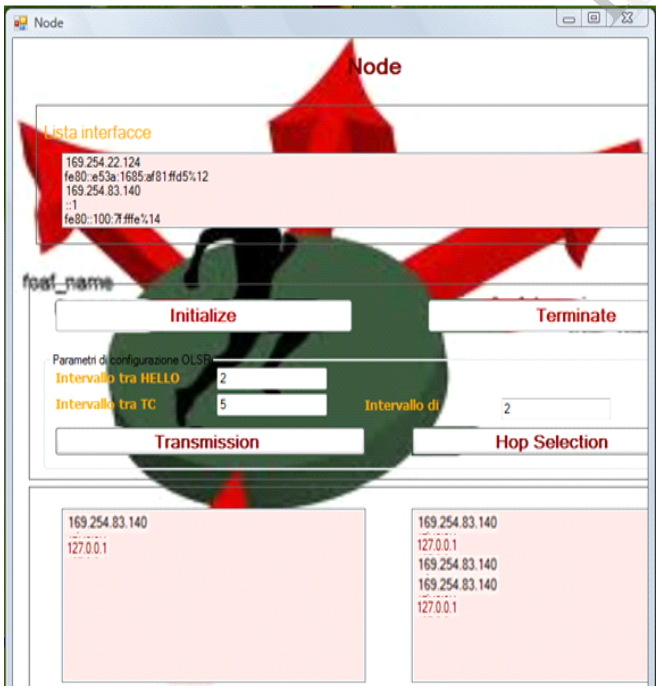

Figure 4 Doctor Module

In the doctor module it also displays the IP address of all the nodes to which it is connected. In the first box it displays the IP address of the source node from which it directly receives the data. In the next box it displays the IP addresses of the nodes from which it receives the data if it is more than one hop.

5. CONCLUSION

Mainly it deals with the improving the QoS in heterogeneous networks. In many methods end to end transmission is used. So any link gets break then the system has to be reinitialized and data has to transmit from the original sender. To avoid this hop by hop delivery method is used in which data is transferred between adjacent nodes from the original sender to the final destination. Here both are implemented via MaT and MiT algorithms. MaT algorithm is for end to end transmission and MiT is for hop by hop algorithm. Two processes are used such as of on-time and at-one-time delivery based on the hop-by-hop transmitting strategy. This Delay Tolerant Network uses the store and forward concept where each and every node stores the data in its memory and forwards to the next node. So if connection breaks no need to transform the data fromthe original sender. The intermediate node can transmit. So its avoiding the retransmission from the original sender. As a result delay reduce and throughput raises.

Future work can modulate each designed component with specific consideration, it can make the Adaptive Transmitting Platform more flexible to equip with real-time transmission and load balance capabilities. After extending related modules with these two capabilities in future investigations, this proposed platform can become a more suitable transmitting platform in Opportunistic Network.

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