

A PDSI-based Static Route Online Configuration Method for QualNet Simulator

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Abstract— Network simulation has been widely utilized to test the rationality and reliability of the network protocols and models before practical implementation. Among the testing and experiments, data transmission based on the static routing protocol is inevitable and a huge repetitive works of static routing pre-setting are needed, especially for the case of large scale networks. In this paper, together with programmable dynamic simulation interface (PDSI), a static route online configuration method for QualNet simulator has been proposed, which allows users to configure static routes through the graphical interface (GUI) during the simulation process. After receiving the online configuration messages, QualNet will parse them, and then update the routing tables according to the time labels as well as the routing parameters. Experiment results demonstrate that the proposed approach is effective and the static routes can be successfully added and removed during the simulations.

Keywords— static route, online configuration, QualNet, network simulation, routing table

I. INTRODUCTION

Network simulation has been considered as a valuable approach to testify network models owing to its time efficiency and low cost. For example, the impacts of different node placements and parameter configuration strategies of network protocols on one scenario can be evaluated flexibly through the network simulators, e.g., QualNet.

Data transmission based on static routing protocol has been essential in many network simulation experiments. Few overhead of routing calculation makes data statistics of experiment results more accurate, and the data transmission delay is shorter [1]. A route search procedure which is limited in a region to reduce flooding with the aid of location information is investigated [2]. In [3], a static routing strategy to adapt to logical network topology changes is proposed, which involves discovery of all possible static routes from a specific source router to destination router, analysing and ordering their applicability.

Although network simulation, which works based on static routing protocol, has the advantage of the credibility, it also results into many repetitive works, i.e., the parameters cannot

be changed by human during the simulation process, especially in the large scale simulations. Even unreasonable setting is found during the simulation, the static routing parameters only can be re-configured until the network simulation progress is terminated. Rather than the conventional approach, an interactive real-time user interface (RTUI) has been implemented, which is a reliable human-in-the-loop framework that allows users to dynamically changing the parameters configuration of network model during the simulation process [4]. Based on RTUI, a programmable dynamic simulation interface (PDSI) is further proposed, which allows users to configure the parameters with the time label to make the parameters modification more precisely [5]. However, the method of online configuration of static routes during the simulation process was not further considered. Hence, it's worth studying how to implement static routing dynamic configuration through simulation for a higher simulation time efficiency.

In this paper, a PDSI-based static route online configuration method is proposed, by which the static routes can be removed or added precisely according to the online configuration messages of users via the GUI. After receiving the messages, QualNet will parse the routing parameters and time labels contained in messages, and pre-catch them into event queues depending on the PDSI. Once the preset time arrives, the static routing table of each node will be updated according to the dedicated parameters. Meanwhile the online configuration progress will not affect the simulation process.

The rest of the paper is organized as follows. Section II describes the proposed online static route configuration method. In Section III, the proposed method is evaluated by intensive experiments. Finally, conclusions are drawn in Section IV.

II. PROPOSED PDSI-BASED STATIC-ROUTE ONLINE CONFIGURATION METHOD

A. Frame of Proposed Method

As shown in Figure 1, the general frame of static route online configuration method is composed of the GUI, PDSI,

and the static routing protocol model in QualNet-based network simulator.

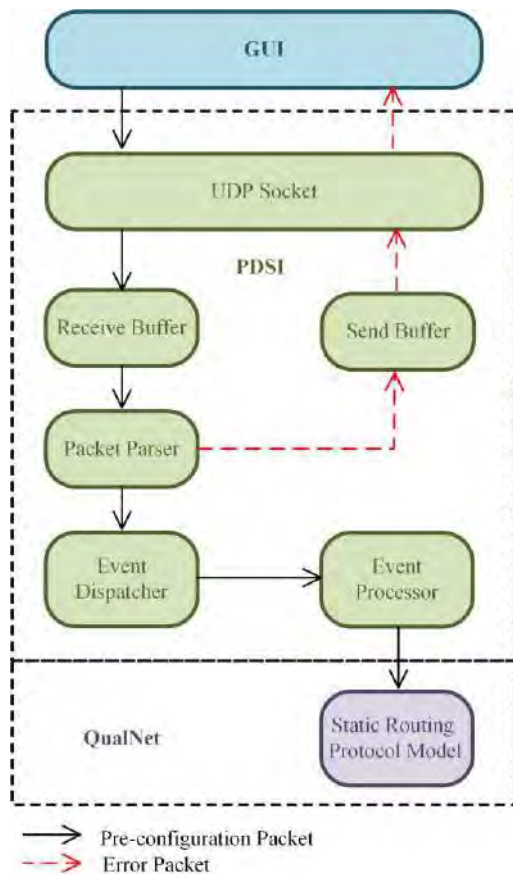


Figure 1. General framework of the proposed method

GUI: Users utilize it to generate the online configuration message, which includes presetting parameters of the static route. These parameters will be capsuled into the uniform format packets as shown in Figure 2, and then sent to QualNet through the UDP socket. Packet type is used to distinguish the function of this message, including adding routes and removing routes. Packet length can help QualNet parse the packet correctly. Execution time defines the dedicated execution time of the parameter updating.

Packet Type	Packet Length	Node ID	Destination Address	Next Hop Address	Execution Time
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Figure 2. The format of packet from GUI

PDSI: As the external interface of QualNet, the PDSI is an essential component in the framework, which combines the GUI with QualNet-based simulator together with the UDP socket, and is responsible for parsing configuration packets into corresponding recognizable messages by QualNet as well as pre-caching them into event queues of QualNet depending on the execution time.

Static Routing Protocol Model: In the QualNet simulator, users need to configure routing parameters of each node by writing a static route file before the simulation starts. At the

process of initializing, each node will set up a routing table whose size is based on the number of routing items. The routing table format is given in Figure 3, which includes node identifier, destination address, and IP address of next hop. To forward a packet, the network protocol needs to know the next node in the path as well as the outgoing interface on which packet are transmitted. When the nodes receive the application data packets, they will parse the head of the packets, which include the destination address of these packets. Then, the nodes orderly search the destination address in their routing tables. Once the nodes find the first matching destination address, they will stop search and send the data packets to the next hop address according to the routing rules. According to this principle, the working procedure of updating routing tables described in Section B.

Node ID	Destination Address	Next Hop Address
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Figure 3. The format of the routing table

B. Procedure of Routing Tables Online Configuration

The flow chart of routing tables online configuration is shown in Figure 4. Nodes will update routing table according to the packet type, the destination address, the next hop address, which are parsed through PDSI.

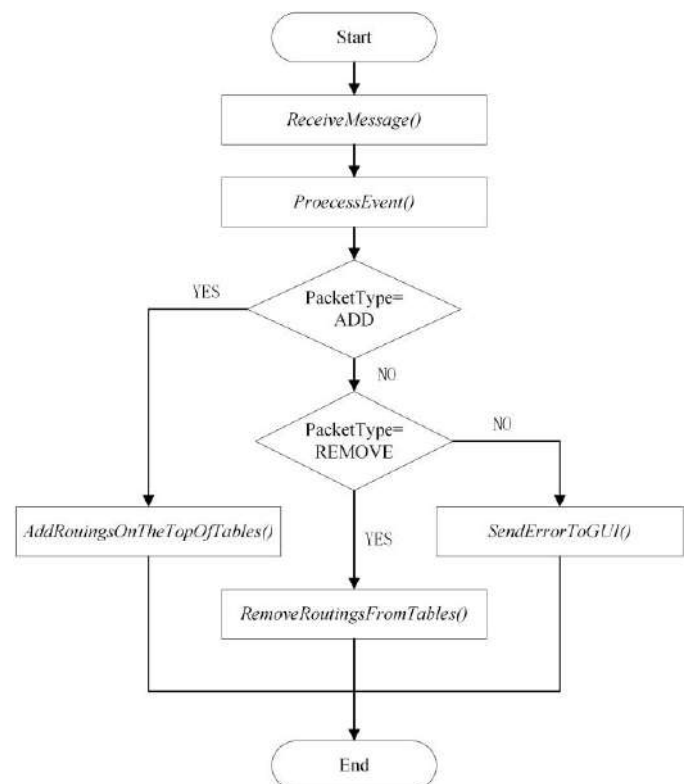


Figure 4. Flow chart of routing tables online configuration

The main functions are listed as follow.

- **ReceiveMessage():** PDSI receives packets from the GUI via UDP socket and parses the online configuration

messages, where packet type, routing parameters, and execution time are included.

- **ProcessEvent():** PDSI inserts different events into the event queue based on the parsed event type and execution time. QualNet will execute events depending on the predefined order according to the online configuration messages.
- **AddRoutingsOnTheTopOfTables():** If the packet type is to add the routes, the new routing information will be added ahead of the routing tables. That is to ensure that the nodes can first find the newly added routing information.
- **RemoveRoutingsFromTables():** If the packet type is to remove the routings, the nodes will find the exactly same routing information with the received information, and then delete it from the routing table.
- **SendErrorToGUI():** If the packet type cannot be parsed correctly, QualNet will return report of error message to the GUI.

III. EXPERIMENT AND RESULTS

To evaluate the performance of the proposed static-route online configuration approach, QualNet 5.1 and a simple graphical user interface are utilized as the simulator and a user operation platform, respectively. Figure 5 shows the scenario run on the QualNet and six network communication nodes applying static routing protocol are placed. Two CBR (Constant Bit Rate) applications with static route are considered in the experiment, those are 1→2 (path1:1→6→4→2) and 1→3 (path2:1→6→5→3).

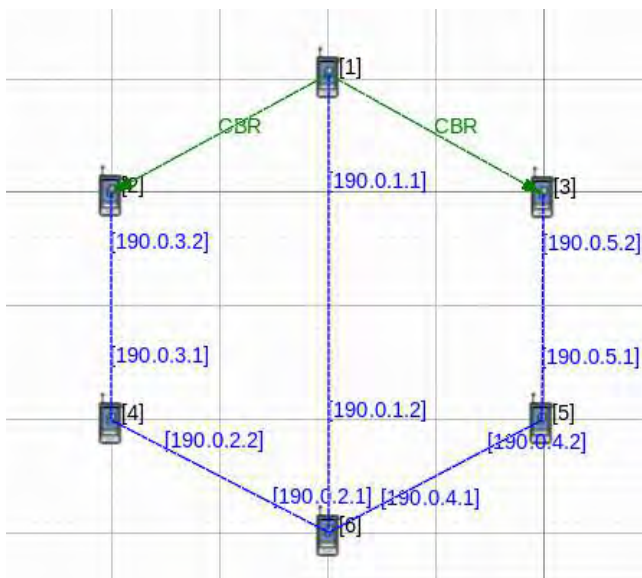


Figure 5. The simulation scenario run on the QualNet

Figure 6 shows the GUI, which is developed to provide convenient interactivity between human users and the simulator. Via the GUI, message of static routes parameters, i.e., the destination address, the next hop address, and the time label during the simulation process, can be generated.

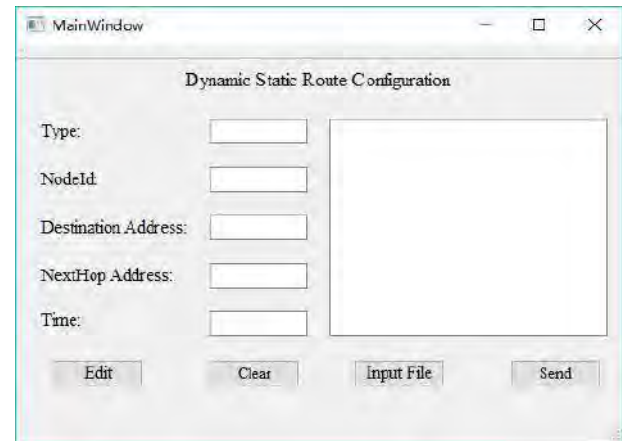


Figure 6. GUI for users to configure the parameters

Before the simulation, the static routing file of QualNet is pre-configured as Table 1. This implies that the CBR application data only can be transmitted through path 1, since nodes 1 and 6 have no static routing information of path 2. The configured parameters of CBR are showed in Table 2.

TABLE 1. PRE-SET STATIC ROUTING FILE

NodeId	Destination Address	Next-hop Address
1	N8-190.0.3.0	190.0.1.2
6	N8-190.0.3.0	190.0.2.2

TABLE 2. PARAMETER SETTING OF CBR

Number of Packets	400
Start Time	1second
Interval	1second
End Time	400 seconds

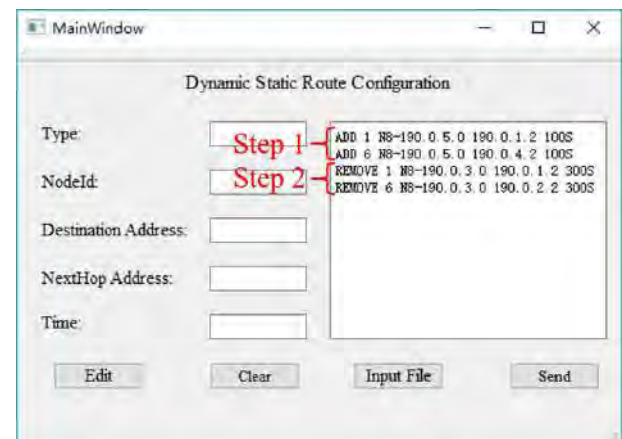


Figure 7. Parameters configured during the simulation process

After simulation starts, the CBR data is successfully transmitted from node 1 to node 2 via path1 (1→6→4→2). In step 1, we first online add the static routes of path2 to nodes 1 and 6, i.e., ADD 1 N8-190.5.0 190.0.1.2 100S and ADD 6 N8-190.5.0 190.0.4.2 100S, via GUI as shown in Figure 7, and the

routing tables at node 1 and 6 are changed as shown in Table 3 at simulation time of 100s. Together with the routing table at nodes 1 and 6, the data generated by node 1 can be sent to both nodes 2 and 3, rather than the case of only node 2 in the previous case with routing table in Table 1.

TABLE 3. TABLE3 ROUTING TABLE OF NODES AT TIME 100S

NodeId	Destination Address	Next-hop Address
1	N8-190.0.5.0	190.0.1.2
1	N8-190.0.3.0	190.0.1.2
6	N8-190.0.5.0	190.0.4.2
6	N8-190.0.3.0	190.0.2.2

TABLE 4. ROUTING TABLE OF NODES AT TIME 300S

NodeId	Destination Address	Next-hop Address
1	N8-190.0.5.0	190.0.1.2
6	N8-190.0.5.0	190.0.4.2

Then, in step 2, the routing of path1 is removed by the online configuration message, i.e., REMOVE 1 N8-190.0.3.0 190.0.1.2 300S and REMOVE 6 N8-190.0.3.0 190.0.2.2 300S, through the GUI as shown in Figure 7. Together with the proposed static route online configuration method, the routing tables of nodes 1 and 6 in Table 3 are changed to those in Table 4 at simulation time of 300s, depending on which only data transmission on path 2 can be successful.

Figure 8 shows the totally received data packets of node 2 and node 3 during the overall simulation process. During the simulation time from 0 to 100s, since only the data transmission along path1 is successful, just node 2 can receive the data from node 1. When the routing information of path 2 is online configured at 100s, both nodes 2 and 3 can receive the data from node 1 as shown in Figure 8. However, when the route information of path 1 is removed at 300s, no more data can be received by the node 2. Thus, a flat trend can be observed in terms of number of totally received packets at node 2.

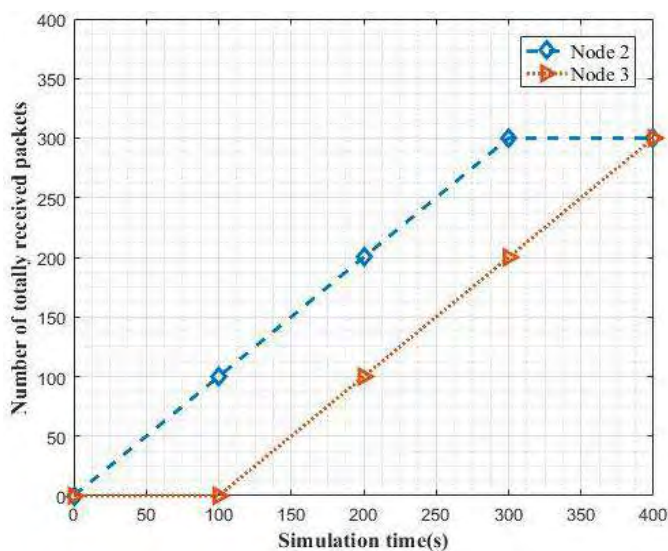


Figure 8. Number of totally received packets by nodes 2 and 3

IV. CONCLUSIONS

In this paper, a static-route online configuration method, by which the static routes can be removed or added precisely according to the online configuration messages of users via the GUI, is proposed for the QualNet based network simulation test. After receiving the messages from the GUI, QualNet will parse the routing parameters and time labels contained in messages, and pre-catch them into event queues depending on the PDSI. And then the event will be parsed at that time. Simulation results have demonstrated that together with the proposed method the static route table can be online reconfigured dynamically during the simulation progress, which is beneficial for the static route based network simulation test, e.g., testing flexibility and efficiency.

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