Path Selection: Reliability Service Curve Measurement to Enhance QOS in MANETs

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Abstract— **In Mobile Ad hoc Networks (MANETs) the mobility of a node is unpredictable and the mobility is considered as one of the characteristics of a wireless network. A fundamental issue arising in MANETs is the selection of optimal path between any two nodes. A method that has been advocated to improve routing efficiency is to select the most stable path so as to reduce the latency and the overhead due to route reconstruction. In this paper, we proposed Reliability aware Service Curve for Path Selection (RSCPS) which is designed to improve the QOS through node stability, amount of data to be transmitted and required bandwidth to send the data. Thus this scheme enhances the existing end to end path reliability.**

Keyword- Path Selection, SCPS, Reliability aware Service Curve, MANET

I. Introduction

In recent years wireless network plays a vital role in data transmission. Ad-hoc network is a kind of wireless network. It does not rely on any pre-existing Infrastructure or centralized system. Nodes in Ad-hoc network may be any wireless device such as Mobile, Laptop, I pad etc. Wireless Ad-hoc network could be classified as MANET (Mobile Ad-hoc Network), WMN (Wireless Mesh Network), and WSN (Wireless Sensor Network).

MANET is a collection of mobile nodes. Mobiles nodes could act as router in case of determining the path for packet forwarding and they rely on each other to keep the network connected. Mobility of mobile nodes leads to dynamic change in topology of the network. Generally network users intended for Reliable delivery of information. But a topological change in MANET leads to Path failure which degrades the network performance. Routing in MANET has been a challenging task because of high degree of node mobility. Using alternative path may resolve this problem. Multiple paths between source and destination are determined by route discovery.

Routing protocol selects an alternative path based on some metrics such as hop count, speed of path, time to deliver content, path reliability, and its bandwidth. Routing problem in MANET has been resolved in our proposal, which is discussed in later part. Routing protocols in MANET are generally classified as flat, hierarchical and position based protocol. Flat routing protocol could be further classified as Proactive (table driven) and Reactive (on-demand driven).

In proactive mode, each node has to maintain information about other nodes in a routing table. This table should be updated often. Some proactive protocols are DSDV (Destination Sequence Distance Vector Routing), CGSR (Cluster head Gateway Switched Routing), WRP(Wireless mesh-network Proactive Routing) etc. Similarly in reactive protocol, each node communicates with other node only on-demand so routing table is not required. Some reactive protocols are AODV (Ad-hoc On-demand Distance Vector routing), TORA (Temporally Ordered Routing Algorithm), DSR (Dynamic Source Routing) etc.

In recent era popularity of time sensitive application keeps rising. Most of the above mentioned protocols do not react well with time varying conditions. For example, AODV protocol will use specific route until link is broken, it depend only on link quality. Some application may require consistent route quality. Time varying nature of MANET service capacity tends to provide hard guarantees on service provided to applications. Service guarantee could be provided only by analysing the reliability of the network. Once reliability of network is good then providing application QOS-awareness is feasible.

In this paper, our objective is to design a Reliable application-aware service curve for path selection mechanism to enhance network performance based on reliability. Link quality analysis is not enough to select an alternative path; instead reliability of each node, path in the network should be concentrated. After ensuring fault-tolerant network, service curve measurement (service capacity of each path), application traffic profile and QOS requirement has been used to choose an alternative path.

II. RELATED WORKS

On-demand multipath routing algorithms discover more than one route in order to replace a broken one with one of the backup routes [5, 8]. They rely on variants of on-demand routing protocols, such as DSR and AODV, to discover multiple routes. The goal is to improve the packet delivery ratio and the average delay per packet by falling back to an operational backup route when the primary route breaks. An alternative approach is to use both primary and backup paths simultaneously to route data. Such a multipath routing approach can better distribute load, resulting in significant decreases in packet loss [9], and, in the case that packets are dispersed across the path set [10], increased fault tolerance. Follow on work [11] has examined how to establish two maximally disjoint paths and select routes on a per-packet basis. None of these protocols addresses the issue of path selection.

In [2] a multipath routing algorithm, called Disjoint Path set Selection Protocol (DPSP), has been proposed that, picks a set of highly reliable paths in nearly linear time. The protocol provides flexibility in path selection and routing algorithm. In a set of disjoint paths, the reliability decreases as the number of paths decreases, and the overall reliability is better than the reliability of every single paths in parallel system. Reliability of link between nodes alone is concentrated here.

In [4] Delay-based Load-Aware On-demand Routing (D-LAOR) protocol has been proposed, which determines the optimal path based on the estimated total path delay and the hop count. This scheme utilizes both the estimated total path delay and the hop count as the route selection criterion. It also has a mechanism in new route selection to avoid a congested node by selectively dropping the Route REQuest (RREQ) packets.

As discussed in [3] the existing protocol, AODV, has the problem of a fragile route. Consequently, a selected route comes to have a short route maintenance time, which causes the overhead of re-establishing a new route. To solve the problem, a new route selection algorithm, AODV-RRS has been proposed to establish a reliable route based on Stable Zone and Caution Zone.

As detailed in [13] the energy constraint of the node is an important issue since energy consumption reduces the wireless network connection lifetime. A probability based node selection method is proposed in this paper for identifying the intermediate node with optimum stored energy that could withstand through duration of connection.

As in [12] selection of the optimal path is an issue. In this paper, both the availability and the duration probability of a routing path that is subject to link failures caused by node mobility are studied. It focused on the case where the network nodes move according to the Random Direction model, and both exact and approximate (but simple) expressions of these probabilities has been derived.

In [1] an effective application-aware path selection mechanism has been proposed to improve end-to end traffic QOS .Chance of node failure and path recalculation during service provision is high. New node may interrupt at any time whose behaviour and consistency could not be analysed as MANET is dynamic in nature. To maintain consistency and reliability in both node and path we propose a mechanism called RSCPS.

III. RSCPS FRAMEWORK

Application and transport layer provides end to end traffic data. A traffic profile is a map of the application protocols used within your network. Popular tools used for monitoring traffic profile are mrtg tool, iptraf tool, rrd tool. Middle layer runs RSCPS. Here reliable nodes and path is selected based on reliability measure and path reliability index. Risk factor involved in each path is calculated which help us to choose most reliable path. End to end service capacity of each reliable path is measured to direct packet in that path. Network layer computes feasible path and forward packet along that path.

To abstract network service capacity (service curve) and application traffic envelope we make use of Network calculus. It provides an elegant model based on Min-plus algebra. Two parameters such as Service curve S(t) describes a lower bound on the amount of data that a network path can serve within(0,t) and traffic envelope E(t) describes a upper bound on the amount of data that the source node can transmit within(0,t) has been used to calculate backlog and delay for end-to-end connection. To improve fidelity of the path, we assume that upper layer send “HELLO” packet along a network path to update path statistics.

Given the traffic envelope for a flow, along with a Reliable service curve for the flow at a fault-tolerant network element, the network calculus provides worst-case bounds on backlog and delay, using theorem1.

A. *Theorem 1*

Assume that a flow A, constrained by arrival curve α, traverses a system that offers a service curve S. The backlog $A(t) - D(t)$ for all t satisfies:

$$A(t) - D(t) \leq \sup_{s \geq 0}\{\alpha(s) - S(s)\} = \alpha \emptyset S(0)$$

Where $f \oslash g(t) = \sup_{s \geq 0}(f(t+s) - g(s))$ denotes the deconvolution of two functions f and g. The virtual delay d(t) for all t satisfies

$$d(t) \leq \sup_{s \geq 0} \min\{\tau > 0: \alpha(s) \leq S(s+\tau)\}$$

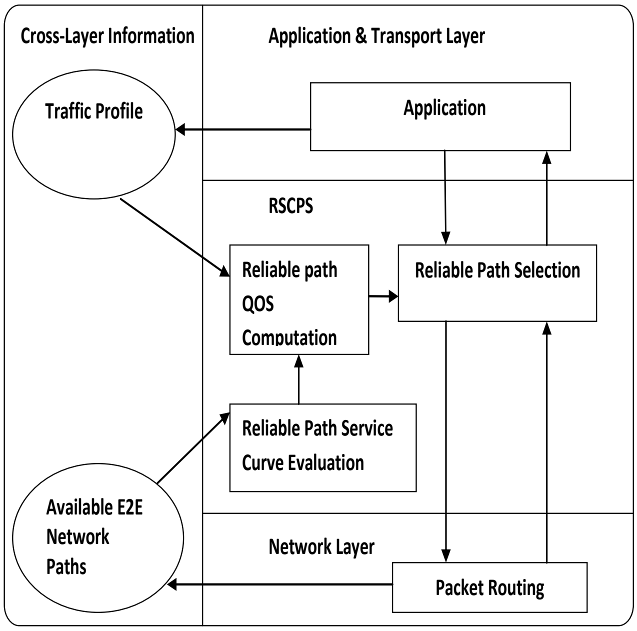

Fig.1. RSCPS Framework

With reference to [12] node stability is termed as reliability and path stability is measured in terms of Risk factor in our proposal. Consistency and reliability of path and node could be attained by introducing extra parameters such as 1.Path reliability index, 2.Node reliability measure, 3.Risk factor. QOS of service curve measurement based path selection specified in [1] could be enriched by introducing above factors before service curve measurement. Subsequent section describes about the factors considered for RSCPS.

IV. RSCPS PROCESS

In past few years, huge number of wireless devices came into play which leads to a thrust on reliability and consistency. Our objective is not directed towards security of data else we focus reliability as consistency of node and path to form a fault-tolerant network. As fault-tolerant network is reliable its QOS would be higher than other network. Some risk factors may occur in our network. For e.g.: Assume 5 nodes say n1,n2,n3,n4,n5 and their node reliability measure is 0,80,85,95,50.Obtained Path reliability index value is 62 which is above threshold value, so we consider it as reliable path. But n1 node has its reliability value as 0 this is the main factor to be noted which is termed as risk factor. Reliability of each node and path should be evaluated to determine risk factor. We use Network calculus to propose path selection mechanism RSCPS. Main steps involved here are Initial path examination, Reliability aware Service curve measurement, and Alternative path selection.

A. Initial Path Examination

Set of paths is acquired from total number of paths by examining path statistics such as packet delay and delivery ratio. Routing protocol discovers and maintains QOS statistics for multiple paths between O/D pair. It works in similar way as specified in [1].

B. RSCPS

It deals with duration and reliability of the nodes but to provide better service available bandwidth of each path should also be determined. Our main objective is to enhance QOS of MANET. In this case node stability is the most important aspect of path selection referred as reliability. Further risk factor is assessed through path reliability; and if node & path reliability is more than specified threshold, which is recommended to calculate the service curve.

Fault Tolerant network is a collection of reliable node and path. Path examination provides us with all alternative paths. Reliability of each path should be assured for better QOS. Routing protocol first examines the node in the Fault-tolerant network using Node reliability measure. Initially, duration of each node within our range is recorded in history. This value helps us to ensure reliability of node by determining how frequent and how long the particular node stabilizes in our range. Mean duration value provides average amount of time that node spend in our range. Ratio between Mean duration of node availability and time to transfer data gives node reliability measure.

Definition of symbols is:

Definition	Symbol
Node reliability measure	*r*
Path reliability index	*PR*
Duration of node reliability	*N(t)*
Time required to transfer data	*T*
Number of nodes in each path	*n*
Less reliable node	*L*
Risk factor	*RF*

$$r = \frac{\sum N(t)}{T}$$

A sample threshold value considered for this paper is 0.7. When an obtained result greater than the level of threshold is known as reliable node else least reliable node.

The term reliability is trying to measure node stability and risk factor using path stability. Reliability of node alone is not enough. To evaluate path reliability, Reliability measure of all the nodes in that path has to be verified.

$$PR = \frac{r}{n}$$

In some cases reliability of node may be below threshold but their average sum would exceed path reliability threshold. If so then that path would be considered as reliable path. This misconception degrades our network performance. As a remedy, we evaluate Risk factor involved in each reliable path. All the nodes which do not meet threshold value are considered to be least reliable node.

Risk factor involved in each reliable path is evaluated using

$$RF = \frac{L}{n}$$

The path which has less risk factor value is chosen as reliable paths.

In Service curve measurement the End-to-end service curve for all reliable paths is identified using an estimation method called Rate chirp. End-to-end probing is used to estimate available bandwidth. Rate chirp uses a single packet train and involves successively decrease in packet gap within packet train thereby covering a range of probing rates. Rate is increased by a constant factor called Spread factor. It is determined by 3 parameters: lower sending rate (Rlow), spread factor, and high sending rate (Rhigh). Source node periodically insert probe in all paths, upon receiving the probe destination can estimate the resources that are implicitly provided on each path. Destination node constructs arrival curve A and departure curve D of sampling probe. Finally by applying Legendre transformation we could recover Service curve S.

C. Alternative path routing

Alternative path could be chosen by destination node with the help of reliability aware service curve, delay and backlog from Theorem 1 and QOS requirement of the application. Chosen path will be informed to source node. It works in similar way as specified in [1].

V. CONCLUSION

In this paper we have proposed a reliability aware path selection scheme which enhances the QOS provided for each application. Resulted reliable paths may yield a greater overall reliability for data transfer. As reliability play major role here, we tend to conclude that proposed system QOS will be better than traditional path selection methodology.

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