Satellite Networks Routing Protocol Issues and Challenges: A Survey

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ABSTRACT: LEO satellite networks play a very important role in broadcasting Internet and connecting remote places at the time of natural calamities. Routing plays a very important role in faster data transfer by taking shortest path. LEO satellite networks are the preferred choice due to less propagation delay and packet loss as compared to GEO satellite network. The multimedia applications and live transmissions cannot bear packet loss, jitter, and timeliness and need the high throughput through the transmission. We did a survey for the best routing protocol for satellite networks.

KEYWORDS: Routing, Satellite Networks, LEO,Quality of Service

I.INTRODUCTION

Today satellite network has become a backbone for communication in various fields like military services, mobile networks, internet etc. Satellite network provides a wide range of coverage throughout the globe and plays a very important

Roledue to its broadcasting capacity and bandwidth flexibility. In terrestrial network many links and nodes are needed to reach the long distance and cover the large areas. The satellite network have great use in providing wide coverage to villages and the places where wired network in not possible like hills and forest. It should be noted that the 2/3 of the world still does not have the infrastructure for the Internet.

The satellite Networks supports higher user scalability through Internet interfaces at customer premises. Satellite systems can be categorised according to their orbits. The Geosynchronous orbit satellites are located over the equator and have the same angular speed as the earth. This means that a geosynchronous satellite keeps its place at the same point in the sky for a reference point on the earth. Its service area is constant and is called a footprint.

When the data, voice, videos and any multimedia is transmitted through the satellite network it has its own parameters like security, packet loss, jitter, bandwidth, cost, transmission rate and so on. Different services have different QoS like file transfer will focus on packet loss, videos or live transmission will focus on jitter and delay.Due to Van Allen Radiation Belts the satellite networks can be at 3 different ranges of altitudes (orbits): Low Earth Orbit (LEO) satellite networks, below the first belt (500-1500 km); Medium Earth Orbit (MEO) satellite networks, between the first and second belt (5000-12000 km); and Geosynchronous Earth Orbit (GEO) above the second belt (above 20000 km).

The resulting end-to-end propagation delay from ground to ground is 20-25msec for a LEO, 110-130msec for MEO and 250-280msec for GEO systems [1] [2]. Therefore LEO satellite networks are one of the most promising communication ways and play a very important role in delivering high quality of data communication.The superior performances of LEO satellite system has been studied through, such as global coverage, low transmission loss, small end-to-end delay and user's mobility [3].

The rest of this paper is organized as follows. In section 2, applications of satellite networks are discussed. Notations of Low Earth Orbit (LEO) satellite constellations are mentioned in section 3. In section 4, the routing in satellite networks is

explained. In section 5, open issues in routing protocols for satellite networks are discussed. Conclusions are drawn in section 7.

II. ROUTING IN SATELLITE NETWORKS

Routing is the act of moving information across an inter-network from a source to a destination. Along the way, at least one intermediate node typically is encountered. It's also referred to as the process of choosing a path over which to send the packets. Routing is often contrasted with bridging, which might seem to accomplish precisely the same thing to the casual observer.

Routing protocols use metrics to evaluate what path will be the best for a packet to travel. A *metric* is a standard of measurement; such as path bandwidth, reliability, delay, current load on that path etc., that is used by routing algorithms to determine the optimal path to a destination. To aid the process of path determination, routing algorithms initialize and maintain routing tables, which contain route information. Route information varies depending on the routing algorithm used.

Routing algorithms fill routing tables with a variety of information. Mainly Destination/Next hop associations tell a router that a particular destination can be reached optimally by sending the packet to a particular node representing the "next hop" on the way to the final destination. When a router receives an incoming packet, it checks the destination address and attempts to associate this address with a next hop. Some of the routing algorithm allows a router to have multiple "next hop" for a single destination depending upon best with regard to different metrics. More details can be found in [17].

The topology of network keeps changing with time. A satellite network goes through a long series of topology-slice of network topology. A topology slice corresponds to topology of the satellite network at particular instant of time. When new ISL is added or an already existing ISL is broken a new topology-slice is formed. Each topology slice has an infinite life time with start and finish time [18].The routing between these topology slice is a difficult task as stated ISL's are adding and broking.

LEO satellite is difficult to meet the requirement of global coverage communication and must from the network. Therefore LEO satellite routing problem becomes critical focus. Weather the routing is good or bad it will directly influence the performance of the whole network and the quality of communication [19]. The different services have different Qos. For example, file transfer focuses on package lost rate, but voice transmission focuses on the delay andjitter. There is no routing algorithm to satisfy all QoS constraint effectively in different services so far which is described in [3].

A. *Classification of Routing Protocols*

The routing problem is divided into two sub problems: Up-and-Downlink (UDL) routing and Intersatellitelink (ISL) routing. In UDL routing the aim is to ensure the connection between to end satellite, one starting satellite and one ending satellite. In ISL routing a hitless handover between start and end satellite must be guaranteed. Most of the routing algorithm deals with the ISL routing. The LEO satellite systems covered small area, the traffic requirement becomes unbalanced due to communication requirements between the rural and urban areas are unbalanced [23].

1) HATS: Handover Optimized Routing Algorithm

The system model is based upon the Globalstar, which comprises a constellation of 48 satellites. The connection state will be stored in the connection matrix, so there are 48 connection matrixes to cover all the 48 topology-slices. The scale of the connection matrix is 48×48, which is able to store all the connection states among the 48 satellites of the Quasi-Globalstar constellation, so the element in the connection matrix is defined as follows:

$$C^k_{ij} = \begin{cases} 1, the\,intraplane\,ISL \\ 1, the\,interplane\,ISL \\ 0, otherwise \end{cases} \quad (1)$$

Here, i, j represent the serial number of the satellite, counting from 0 to 47 while the k represents the serial number of the topology-slices, counting from 1 to 48. In these connection matrixes, we deal with the intraplane ISLs and the interplane ISLs as the same. From the elements of the connection matrix, we can find the whether the ISL exist between the satellite i and satellite j in the kth topology-slice.

2) Destruction Resistance Routing Algorithm

Dongni et. al [22] algorithm concretes on avoiding invalid ISL's and reroute with the cost as smallest as possible. Satellites networks are using off line initialization strategy in which routes from each satellite node to all others are computed in advance. Based on selected ISL's, a set of virtual path (VPs) can be built between two adjacent satellite nodes, and VPC routes can be constitute, with each satellite will be consider as an ATM switching. The two sub-procedures called Cluster Initiation which is designed off-line and reclustering which is designed to decrease the algorithm complexity and guarantee the reformed clusters still accord with the off-line cluster initiation rules to most extent. Both the procedures are following several rules which can be found in [22]. In one of the conditions firstly, when the clustering head in unreachable and secondly, when he broken intra-original-cluster ISL between reformed clusters reconnects. The destruction resistance routing algorithm and OSPF is applied to four kinds of scales with different nodes and clusters. The efficiency is calculated using simulations. The signalling overhead for the destruction-resistance algorithm is smaller than OSPF, especially under the condition without any faults occurring, the signalling overhead is very small, yet the routing efficiency is equal to OSPF. The signalling overhead increases when some ISLs become faulty, but it rather happens to the involved cluster-heads and nodes near the faulty ISLs and, as the number of involved clusters increases, the signalling overhead gets larger, yet the routing efficiency gets closer to those optimal and the simulation results can be found in [22]. In [19] a solution to ISL (inter satellite link) routing problem is given. A DODT algorithm for LEO satellite has been designed with a purpose of reducing signal overhead and to ensure high performance of resistance to destruction (HPRD). An on-demand DODT routing algorithm based on DT-DVTR is introduced for satellite networks. This new algorithm is able to avoid congested links by making local decisions or reversing links.

3) Routing Mechanism based on Steiner Tree

In paper [26] a new Inter Linear Programming (ILP) formulation and a distributed algorithm have been designed. Whereas in paper [1] a new routing mechanism and a protocol has been designed.

In [26] a bandwidth-efficient multicast routing mechanism using RST's (rectilinear Steiner Trees) for IP-based LEO satellite networks is proposed. A new ILP formulation requires less computational time then for general Steiner trees. A distributed algorithm and protocol has been designed which proves that multicast tree generates by this algorithm is 40% less bandwidth then the shortest path tree which is described in [26]. Where as in [27] ZhianYanga propose a dynamic QoS routing mechanism to selects the suitable algorithm to satisfy the QoS constraints according to the types of the received multicast services. Aprotocol to aggregate the global and make a lode balance of satellite network is proposed in [27].

d) Distributed Multipath Routing

In paper [30], Satellite network can be divided into fixed slice on which terrestrial routing can be applied. This distributed datagram routing deals with the problem of IP with Leo satellite network. The disadvantages are the broken ISL's links which leads to degradation of performance.

MASMR is a product integrating Multi-Agent System and satellite network routing technique. Referring the common framework of ACO algorithm, MASMR has some improvements according to the characteristics of satellite networks. MASMR contains two kinds of agents: mobile agent and node agent. Mobile agent is classified into forward agent and backward agent. Forward agent is responsible for network exploration and information collection, while backward agent inherits the routing information of the forward agent, and updates routing and pheromone table. Node agent is generated by

a satellite node and bound to the node. Node agent is in charge of applying for a memory space to record the useful information carried by the backward agent. Node agent continues recording the optimized routing information and deleting the outdated information, just like a blackboard on which new words are written and then unwanted words are erased.

V. OPEN ISSUES: ROUTING PROTOCOLS FOR SATELLITE NETWORKS

The satellite is playing an important role in various applications like defence and telecommunication. To ensure quality of services research in this field is growing and giving a new way to researchers. Here we discuss various open issues and hot research areas in the field of Satellite Networks [27][30][38][39][40].

- To reduce the routing overhead of a dynamic QoS routing in a different traffic is a challenge.
- GEO satellites have advantage of technological maturity and good coverage but due to high delay and attenuation limits transmitting real time information becomes a problem. A single layer LEO satellite network has bad performance on transmitting long distance. How to combine advantage of both the satellite to improve network performance is a hot research.
- Multicasting datagram in the satellite networks to achieve larger coverage area on the terrestrial infrastructure is a research topic.

VI. CONCLUSION

Satellite Networks plays important role in every aspect of the human life. In order to increase the performance of the satellite network,efficient routing technique is needed.Effective routing metrics in the protocol enhances its efficiency in the networks. In this paper, survey on routing metrics and satellite networks routing protocols is presented. Routing protocols for Satellite Networks are classified based on QoS, multicast, and multipath. The routing is doneby using algorithms like ATM and switching, satellite network topology can be divided into a series of fixed slices on which the terrestrial routing algorithms can be applied. Steiner Trees algorithm, to reduce the on board computing. The open issues in Satellite Networks routing are identified and discussed.

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