Effective Multihop Scheduling Routing Scheme for Real Time Congestion Status of Satellite Constellation

S.Surya[1], M.Berlin Mary[2], G.Jayaraman[3]

P.G.Scholars, Department of CSE with Specialization in Networks, Francis Xavier Engineering College, Tirunelveli[1,2]
Assistant Professor, Department of ECE, Francis Xavier Engineering College, Tirunelveli[3]

***Abstract*— This method leverages limited packet redundancy to speed up the packet transmission, i.e., each source node is allowed to distribute at most f copies of each packet in its delivery process. Specifically, this effective multi-hop scheduling routing scheme under the correlated mobility model develops the closed-form expressions of both per node throughput capacity and expected end-to-end delay. Further this method consider how packet redundancy affect throughput capacity and end to end delay, and find that the packet redundancy f can help to achieve a more flexible tradeoff between capacity and delay in correlated node movements and also conduct simulations which validate the theoretical results and demonstrate the throughput and delay performance of the new multi-hop scheduling-routing scheme.**

***Index Terms*— End to End delay, Multi hop Scheduling Routing Scheme, Throughput Capacity**

I. Introduction

The majority of satellites currently in operation are placed inGEO orbit. The GEO satellite is 35,786 km above the equator,and its revolution around the Earth is synchronized with the Earth's rotation. While GEO satellite has the advantage ofvery large coverage area, it also has some drawbacks suchas high orbit lift costs, requirement for large antennas and high transmission powers and, most significantly, the largepropagation delay. The typical value of end-to-end propagation delay is 250-280 ms, which is undesirable for real-time traffic.MEO's distance from the Earth's surface is from 3000 km up to the GEO orbit with a typical end-to-end propagation delay of 80-100 ms.

LEOs are located 200-3000 km abovethe Earth's surface. For a LEO satellite the end-to-end delay is 20-25 ms, which is comparable to that of a terrestrial link.Since LEO/MEO satellites are closer to the Earth's surface,the necessary antenna size and transmission power level aremuch smaller; but their footprints are also much smaller. A constellation of a large number of satellites is necessary forglobal coverage. The lower the orbit altitude, the greater thenumber of satellites required. In addition, since satellites travelat high speeds relative to the Earth's surface, a user may needto be handed off from satellite to satellite pass rapidly overhead .When it comes to service delivery, each type of satellite orbit has its own set of drawbacks and advantages.

Forinstance, in very simplistic terms, the geostationary orbit couldbe considered to be more suited to the provision of regionally deployed, non-delay sensitive services, whereas the low Earthorbit in comparison may be better suited for global, real-timeservice delivery. Therefore, multi-layered satellite architectures with inter-orbital links (IOLs) between layers of satellite constellations, i.e. hybrid constellations, are of much interests it yield much better performance than individual layers.For instance,a three-layered architecture consisting of GEOs, LEOs and high altitude platforms (HAPs) is proposed.GEOs act as backbone routers, LEOs as the second layer andHAPs to cover special areas with high and sensitive traffic suchas battlefields and disaster areas. In the simulation studiesdeduce that Satellite over Satellite (SOS) networks have better performance than that of Flat Satellite Networks (FSN).

On-board processing is a general term that refers to signal processing and routing functions implemented on-board the satellite that go beyond the amplification and frequency con-version performed in conventional, transparent satellite systems. The OBP in satellites eliminates the inherent disadvantages of the"bent pipe"transponders. The main advantages of satellite systems with OBP are: improved link quality with respect to transparent systems due to signal regenerationon board, efficient bandwidth and power level control by multi-beam frequency reuse which increases satellite rawcapacity, discarding empty uplink time slots resulting in increased efficiency of downlink transmission, dynamic reallocation of unused bandwidth, asymmetric uplink and downlink bandwidth to take advantage of traffic statistics, on-orbitmanagement of network traffic, capacity and QoS, statistical multiplexing which supports varying degrees of busty traffic, direct interconnections between user terminals through on-board switching.

OBP can support high-capacity inter-satellite links (ISLs) connecting two satellites within line of sight. Switches in the satellites provide short latency and thus improve the quality of service (QoS) with regard to systems using hub stations on ground. By using a sophisticated constellation with ISLs, connectivity in space without any terrestrial resource is possible. This feature enables far more autonomous satellite networks which may be imperative especially for military purposes and post-disaster-communications situations, where ground facilities may become potential targets or be damaged. These benefits, however, demand payloads with higher complexity. With more advanced and powerful integrated circuitry and microelectronics, OBP has become more feasible and sensible cost-wise. Thus it has the potential for enabling satellite networks to cope with the inherent propagation delay obstacle and contribute to the performance of VoIP applications over satellite networks.

In this setup, there are 66 LEO satellites distributed in 6 planes each consisting of 11 satellites. Satellites are identified by their numbers between 1-66. Each LEO is connected to two neighbors in the same plane and two other satellites in the neighboring planes by inter-satellite links (ISL). Gateway stations (GS) are directly connected to satellites via user data links (UDL). The world is divided into 6 coverage areas corresponding to each LEO plane footprint. There are 44 GSs in each region. Although the world's population, its distribution and communication patterns imply non uniform traffic density in practice, this non-uniformity is not taken into consideration to keep scenarios simple and easy to manage.

In this scenario, ICO is chosen as reference MEO constellation. There are 10 MEO satellites in2 planes in ICO's constellation. Actually, ICO satellites are bent pipe satellites, but in this case, it have inter-satellitelinks with the neighboring satellites. Like LEO satellites considered in previous case, each MEO satellite has four ISLs- two inter-plane and two intra-plane. Similarly, tworouting tables are used for inter-plane and intra-plane routing. Dijkstra's Shortest Path Algorithm is used also in this scenario.

II. EXISTING SYSTEM

The Celelstri Architecture [1] will allow for the use of relatively small, low power and low cost earth terminals. It will also permit real-time communication capabilities: the delays experienced by end-users will be essentially equivalent to terrestrial communication systems for global real-time services.Each satellite contains all of the hardware necessary to route communications traffic through the network, including Earth-to-space, space-to-Earth and space-to-space connections.

With this architecture, a signal received by a satellite may be transponder directly back to Earth in the same or a different beam or relayed by optical inter-satellite links through other satellites from whichit is then transmitted to Earth. This architecture allows global interconnection for the provision of real-time multimedia, data, video and voice services. The system is designed to avoid harmful interference with other service operators primarily through the use of space diversity.

This technique will allow the Celestri LEO System to share the same spectrum with multiple NGSO andGSO systems, on a co-coverage and co-frequency basis. Implicit in the spectrum sharing approach is the assumption that all NGSO systems will participate in the spectrum sharing responsibility.The system will utilize multi-beam phased arrays with fixed beams to provide ubiquitous coverage through the satellite footprint. Single or multiple earth terminals will provide access to the satellite constellation. The earth terminals will have equivalent antenna aperture sizes from 0.3 to 1 meter and will support bit rates from 2.048 to 155.52 Mbps.

MLSNs [2] are, however, not without their shortcoming, particularly when it comes to congestion. Some satellites in a MLSN may experience traffic congestion as the number of users in the network increases. This may happen as an effect of the non-homogeneous distribution of source and destinationusers on the ground. For instance, heavy traffic load tends to overwhelm a satellite, which covers the area of a relatively large city. It may eventually lead to loss of packets and increase of end-to-end delay, which pose serious problems to the
Communication.

An example of a typical MLSN constructed by LEO and MEO satellites, and the non-homogeneous traffic distribution. As shown in the distribution of the MLSN users on the ground tends toconverge in specific areas (such as North America and Europe) in contrast with the sea areas. As a consequence, some LEO satellites covering the highly dense populations receive much higher volume of traffic. Moreover, the non-homogeneous traffic distribution in the LEO layer causes the biased converging of traffic at the MEO satellites.

To solve the serious problem of the above mentioned traffic congestion, to propose, in this paper, a new MLSN model witha method to distribute packet flows between the LEO and MEO layers. In this model, to focus upon expanding the coverage of the satellite on the upper layer to increase the number of links between the LEO and MEO satellites that enables bypassing ofmore traffic flows. In addition, to analyze the overall communication delay (which includes both the propagation and queuing latencies within the considered MLSN) and the number of the above mentioned bypassing links.

Multilayered satellite networks (MLSNs) [3] have been proposed recently as a practical architecture for next-generation satellite networks. MLSNs are constructed by integrating several satellite networks and have hierarchical structures. An example ofa typical MLSN is a two-layered MLSN which is composed of a low-Earth-orbit (LEO) constellation and a medium-Earth-orbit (MEO) constellation. MLSNs are constructed with several types of links. First, inter-satellite links (ISLs) connect each satellite within each constellation and form a mesh or ring topology.

In addition, satellites in different layers are connected by interlayer links (ILLs) in the MLSN. There, terrestrial users connect to the satellites via ground–satellite links (GSLs) and, thus, are able to communicate with each other. Integration of these multiple networks provides various advantages including reinforcement of the network capacity, an increase in available paths, the possibility of hierarchical network management, and so forth. However, there are also various issues that have to take into account to effectively utilize MLSNs.

Guaranteeing quality of service (QoS), handover management, and load balancing among the satellite layers are among the significant concerns involving MLSN. In this paper, focus on the particular problem of load balancing among the layers (i.e., the satellite layers in theMLSN). In the MLSN, it is necessary to utilize satellites in each layer for fulfilling specific purposes.

The existing proposal allocates different roles to the satellites in each layer toreduce the overhead of network management and guarantee users' QoS. However, the traffic from users must increase as broadband satellite communication environments are developed and deployed. This will require the load balancing method to efficiently utilize network resources in the MLSN. For this reason, developing innovative route control schemes to efficiently distribute traffic at each network layer is, indeed, an urgent task.

III. PROPOSED SYSTEM

The ever-increasing traffic congestions, accompanied by unpredicted emergencies and accidents have motivated the development of intelligent transportation systems (ITS). ITS has various applications, ranging from traffic surveillance, collision avoidance, to automatic transportation pricing. Among others, traffic control at intersections has been always a key issue in the research and development of ITS. Based on the mechanisms used, existing approaches can be categorized into two classes. Traffic light scheduling is the traditional approach, where vehicles proceed in a stop-and-go style according to the occurrence of green light. Recent efforts on traffic light control focus on adaptive and smart traffic light scheduling, mainly by making use of computational intelligence, including evolutionary computation algorithm, fuzzy logic, neural network and machine learning. Adaptive approach based on real-time traffic volume information collected from sensor networks has also been studied. However, due to the dynamics of traffic load, traffic control systems are large complex nonlinear stochastic systems, so determining the optimal time of green light is really hard even if not impossible.

Moreover, the complexity of computational intelligence algorithms makes them usually not applicable to real-time traffic light control. More recently, advanced sensing and communication technologies enable real-time traffic-response green light control. The traffic light is scheduled under a certain control strategy according to real-time traffic data and predefined logic rules. The other approach, trajectory maneuver is totally different from traffic light control. An intersection controller is deployed to optimally manipulate vehicles' trajectories based on nearby vehicles' conditions so as to avoid potential overlaps. The vehicles and controller communicate via wireless links. With trajectory maneuver, the vehicles can move smoothly without stop and thus may improve the efficiency of the system. Different methods have been studied to calculate the optimal trajectories, including cell-based, merging, fuzzy logic, scenario-driven, global adjusting and exception handling, etc. Similar to optimal traffic light control, trajectory maneuver is a hard problem due to the complexity of trajectory calculation. Inspired by recent advance vehicle technologies, we propose a novel approach based on distributed coordination among vehicles.

Vehicular ad hoc network (VANET) enables a vehicle to communicate with other vehicles (V2V) or infrastructures (V2I) via wireless communications. Then, vehicles can not only collect information about themselves and their environment, but they also exchange this information in real time with other vehicles. On the other hand, sensor and embedded technologies are making autonomous vehicle (AV) more and more feasible and practical. For example, Google's driverless car has been running on the road. With the help of above technologies, we propose to control the vehicles at intersections by letting vehicles compete for the privilege of passing via message exchange.

A vehicle sends request to others and it can pass after permission from others is collected. How to realize such coordination of privilege control is at the core of our approach. We model the problem as the vehicle mutual exclusion for intersections (VMEI) problem, a new variant of the mutual exclusion (MUTEX) problem. In the classic MUTEX, all nodes access the critical section (CS) mutual exclusively, i.e., at most one node can be in CS at any moment.

Although researchers have found and defined several other variants of MUTEX, including k-MUTEX, group MUTEX, the dining problem (DP), the drinking problem, and local MUTEX, they cannot describe the problem of traffic control at intersections. The supplementary file for the detailed discussion on existing MUTEX variants, available online. Then, to solve the VMEI problem, we design two algorithms for VMEI. The first one is a centralized algorithm, where a control center node is deployed at the intersection area.

Compared with existing intersection control approaches, including traffic light control and trajectory maneuver, our MUTEX based approach is quite different. It directly controls individual vehicles, which is similar to trajectory maneuver, but vehicles move in a stop-and-go style, as in traffic light system. Moreover, different from either of existing approaches, our distribute algorithm coordinate competition in an ad hoc way, without any centralized facility is involved. Accordingly, our approach has two major advantages. 1) It is efficient and flexible, because the vehicles are directly controlled with real-time information and resources are fully used. 2) It is simple and not costly, because no optimization mechanism is involved and no centralized facility is necessary.

This scheme provides an effective multi-hop scheduling-routing algorithm for packet transmission under the correlated mobility model. We extend the simple yet effective two-hop f-cast relay algorithm for the most effective way to transmit packets over inter and intra-groups. Based on the general multi-hop scheduling-routing algorithm, this scheme develops the closed-form expressions of both per node throughput capacity and expected end-to-end delay. More importantly, this work provides us an in-depth understanding of how the packet redundancy affects network performance in correlated node movements.

IV. RESULTS AND DISCUSSION

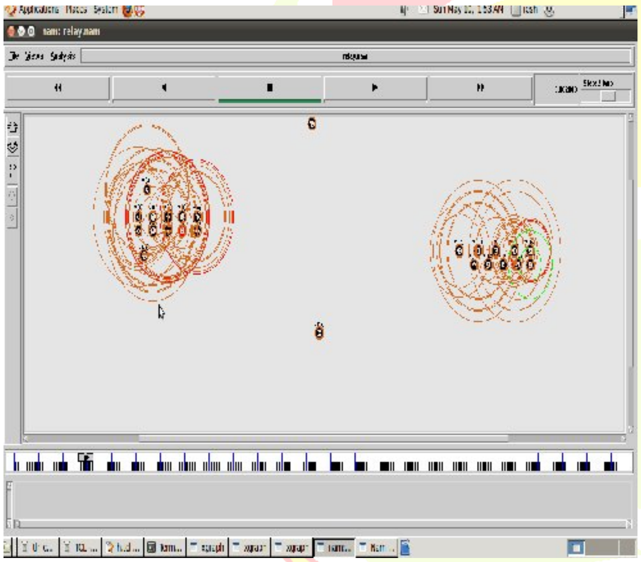

Fig.1. Data transmission between internal nodes

Fig.1. shows that the data transmitted from the set of nodes to its neighbor node about traffic information. In each direction the data transmitted to its neighbor nodes and the neighbor nodes are transmitting the traffic related information to other nodes.

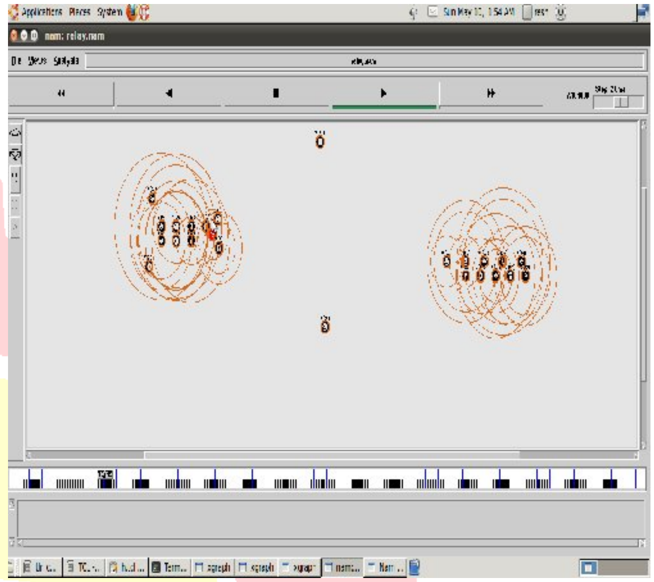

Fig.2. Traffic flow

Fig.2. shows that the traffic occurs between the internal nodes and its avoided by the sending the traffic related information to its neighbor.

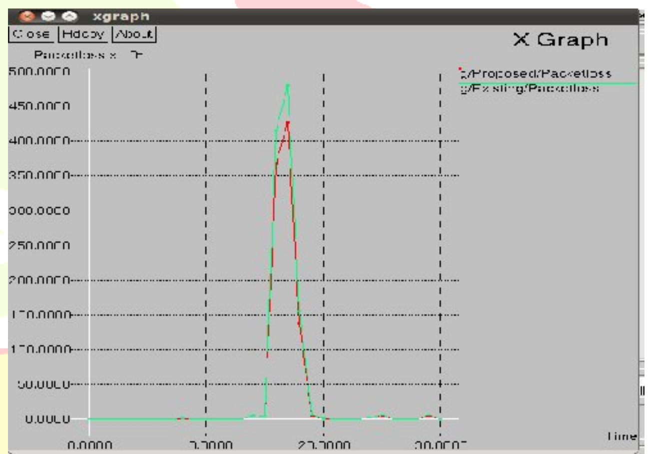

Fig.3. Packet loss graph

Fig.3. shows the packet loss graph. The graph is plotted between time versus packet loss. The graph shows the comparison of existing system packet loss and proposed system. The green color line indicates the existing system packet loss. In existing the packet loss goes to peak value due to attacks during data transmission. The red color line indicates the packet loss of proposed system. There is a packet loss present in the proposed system but it is less compared to existing.

V. CONCLUSION

This method leverages limited packet redundancy to speed up the packet transmission, i.e., each source node is allowed to distribute at most f copies of each packet in its delivery process. Specifically, this effective multi-hop scheduling routing scheme under the correlated mobility model develops the closed-form expressions of both per node throughput capacity and expected end-to-end delay. Further this method consider how packet redundancy affect throughput capacity and end to end delay, and find that the packet redundancy f can help to achieve a more flexible tradeoff between capacity and delay in correlated node movements and also conduct simulations which validate the theoretical results and demonstrate the throughput and delay performance of the new multi-hop scheduling-routing scheme.

REFERENCES

[1] T. Taleb, D. Mashimo, A. Jamalipour, N. Kato, and Y. Nemoto, "Explicit load balancing technique for NGEO satellite IP networks with on-board processing capabilities," IEEE/ACM Trans. Netw., vol. 17, no. 1, pp. 281–293, Feb. 2014.

[2] Y. Rao and R. Wang, "Agent-based load balancing routing for LEO satellite networks," Comput. Netw., vol. 54, no. 17, pp. 3187–3195, Dec. 2013.

[3] H. Nishiyama, D. Kudoh, N. Kato, and N. Kadowaki, "Load balancing and QoS provisioning based on congestion prediction for GEO/LEO hybrid satellite networks," Proc. IEEE, vol. 99, no. 11, pp. 1998–2007, Nov. 2013.

[4] Y. Kawamoto, H. Nishiyama, N. Kato, N. Yoshimura, and N. Kadowaki, "Assessing packet delivery delay in multi-layered satellite networks," in Proc. 2012 IEEE International Conf. on Commun., pp. 3311–3315.

[5] R. Mauger and C. Rosenberg, "QoS guarantees for multimedia services on a TDMA-based satellite network," IEEE Commun. Mag., vol. 35, no. 7, pp. 56–65, July 2011.