Based on SDNRouting Mechanism of Spatial Information Network Based on and Contact Graph*

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Abstract: Space information network has network Heterogeneous, topology time-varying, network node storage and calculation ability limited, space equipment maintenance and upgrade is not easy to Characteristics, this show that space information network large spatial and temporal span network system structure, dynamic network environment routing technology and problems need research to solve. So put forward the Based on Software Defined Network (Software Defined networkingSDN) And contact figure of space information network routing mechanism. First for Space Information Network in network Heterogeneous, equipment maintenance upgrade difficult to the problem introducedSDNData Control separation establish network structure. Then for space information network topology periodic Dynamic Change of characteristics put forward based on contact figure of is expected to much path routing strategy and dynamic response routing strategy. Simulation results show that the routing mechanism can enhance data transmission rate and network fault response ability is feasible and effective.

Keywords: Space Information Network; Software Defined network; contact figure; Routing

Literature sign code:A

1. Introduction

Space information network is by satellite, near space aircraft, spacecraft and corresponding ground facilities such as composition of comprehensive integration network[1]Not only can service in ocean navigation, emergency rescue, navigation positioning, Aviation Transport, space measurement and control and other major application and can support the to observation of high dynamic, wide-band and real-time transmission and[2]. But space information network equipment replacement difficult, technology update is not easy to, resources limited, network topology dynamic change, link transmission when extension of characteristics control the its development in addition, A large number of new network application the emergence of has also led to network in energy consumption surge the problem by academic circles and industry of widely attention[3-4]. Especially is Next Generation Space Information Network will present more rich of characteristics such as platform environment different, network Heterogeneous, communication flow big such. These characteristics of lead to the existing of network architecture no longer applicable urgent need new of system structure, new of protocol and Routing Mechanism support space information network development.

Software Defined Network (Software Defined networkingSDN) Is a kind of new of data control separation, software programmable of Network System Structure[5] It allow data plane and control plane run in physical distance far of two equipment on by control plane responsible for the network centralized control make new features of deployment

and implementation more flexible. In addition data and control of height decoupling of help control plane of programmable of the realization of to simplified network operation and maintenance flexible network management and scheduling of target[6]. AccordingSDNThe idea is introduced into the architecture design of Spatial Information Network, which is conducive to improving the difficulty of maintenance and update of devices and the limited storage and computing capacity of network nodes. Mu

At home and abroad, the study of the combination of the two is still in the initial stage, but there is no more mature theoretical results.SDNIt is necessary and urgent to research the Routing Mechanism of Spatial Information Network.

The contact graph abstracts the dynamic network topology as a connection plan, which includes two types of data information, namely the contact opportunity data and the contact distance data, which are used to describe the link connectivity, the latter describes the link distance attribute[7]. The contact graph-based routing technology was first developed in deep space exploration and later popularized in the ground delay tolerant network. It can calculate multiple paths at the same time, and considers the consumption of link bandwidth, it can be used for centralized routing calculation based on prior knowledge and for node distributed routing calculation. The Space Information Network belongs to the category of delay interrupt tolerant network. Its Backbone Transmission Network is composed of satellite network.

To sum up, this paper aims at some existing problems of space information network andSDNBased on the current research situation, this paper proposesSDNSpatial Information Network Routing Mechanism of contact graph. The purpose of this design is to improve the maintenance and update of space information network equipment and the limited storage and computing capacity of network nodes, and strengthen the network fault response ability, achieving high efficiency and high reliability of data transmission.

2. Related work

SDNThe idea of introducing spatial information network architecture design has a very high application prospect.

Literature[8]Proposed software-defined satellite network frame

(Opensan), The data forwarding function and control calculation function of the satellite are decoupled, and the data plane, control plane and management plane of the satellite network are obtained. But,OpensanThe architecture relies heavily on ground facilities. Once the ground facilities are paralyzed, the satellite network will not function properly. And becauseOpensanWillGEO(Geo-stationary Earth orbit) The satellite group is set to the Controller for Command Translation between the data plane and the management plane, ignoringGEOThe problem of the highest operating orbit height and high delay, which will affect the real-time response ability of the whole network. Literature[9]Proposed willSDNAnd virtualization for broadband satellite networks. Through detailed application scenarios analysis,SDNCombination of necessity and advantages. Literature[10]Put forwardSDNKey solutions deployed in satellite communication networks will bring improved coverage, optimized use of communication resources and better network resilience, as well as improved innovation and business flexibility, to deploy communication services through a composite network.

At present, the research on spatial information network routing mechanism is still deepening. Literature[11] First timeATM(Asynchronous Transfer Mode) Network routing technology is introduced into satellite network, and a virtual topology strategy based on slot partition is proposed to achieve the balanced distribution of network traffic load and reduce the impact of traffic on satellite network routing. However, this strategy will cause a large number of Time Slot topology sequences in the system cycle, and the routing calculation usually takes offline centralized computing mode, so it is impossible to balance the communication traffic and network resources. Literature[12]A routing mechanism supporting load balancing is proposed to mitigate the impact of traffic on satellite network routing. In order to fundamentally improve the real-time dynamic response ability of the network[13]A Distributed datagram routing protocol is proposed. First, the virtual node strategy is used to shield the

satellite's relative ground mobility, and then the distributed strategy is used to achieve the shortest propagation delay routing. Connectionless routing mechanism eliminates the impact of network emergencies to a certain extent, but relies on-board routing computing, which poses a challenge to the computing and storage capacity of satellites, and the routing decision is limited to the regular satellite constellation, which has poor scalability. Literature[14]Firstly, a multi-layer satellite network architecture is proposed, and a layered QoS routing protocol is designed and implemented (Hierarchical QoS Routing Protocol,Hqrp). Literature[15]ProposedLeo(Low Earth Orbit)/MEO(Medium Earth orbit)/GEO

Routing Protocol for three-tier Satellite NetworkMlsr(Multi-layered satel-lite Routing).

The results show that the contact graph routing mechanism is usedLeoSatellite Network has very big advantage. Contact figure routing (Contact graph RoutingCGR) Algorithm is based on flow particle size generation of but routing calculation process more of is under hop node does not take into account the path of there so data every transmission to a node, all to start a routing program. Literature[17]WillCGRRouting Mechanism extended to opportunity-connection network scene in enhance the routing mechanism "with the flexibility is expected to make its become all kinds of heterogeneousDTN(Delay tolerant Network) In the implementation of the Core routing mechanism implementation heterogeneous network of Internet exchange for example ground network and space network between the communication.

3. Overall Design describe

3.1 Network Function Model Design

In this paper, the design of the space information network including network control center and backbone transmission network its user main divided into space user and ground user its network structure as shown in Figure1Shown in.

NCC(Network Control Center) For ground global controller responsible for management space backbone in all satellite equipment this is becauseNCCIs located in ground hardware facilities of replacement and software facilities of deployment, update and maintenance are than in space environment under easy

to operation and can achieve.NCCStorage the whole network of State data don't storage flow table don't responsible for data transmission can andMEOLayer andGEOLayer satellite establish inter-satellite link.

MEOLayer satellite of Space local Controller Management neighbor node satellite becauseMEOSatellite of end-to-end transmission delay, delay jitter and emission difficulty and performance index were betterGEOSatellite and its

Calculation and storage ability is betterLEOLayer satellite.MEOLayer satellite can storage neighbor satellite network link state and flow table responsible for data transmission can andNCC,GEO,MEOAndLEOSatellite establish inter-satellite link.

GEOLayer satellite has spread delay big signal attenuation serious Track location resources limited can't cover polar regions and other defects should not be used as a controller but its natural has broadcast forwarding Ability, should be for exchange equipment ".GEOLayer satellite placed have flow table canNCC,MEOAndGEOEstablish inter-satellite link.

As an exchange equipment,LEOLayer satellite can will original control level of function separation out simplified system implementation difficulty.LEOLayer satellite also placed have flow table canMEO,LEOLayer satellite establish inter-satellite link.

In addition ground global controller and space local controller model were by control module, storage module, calculation module and port module composition. But two class controller in some module of specific function there some difference: Global controller of control module than local controller of control module. The local controller of management function; global controller of storage module contains global network knowledge base and global network path information local controller of storage module contains local network knowledge base, flow table data and cache space. Switch Equipment contains management module, storage module, port module and link found function module.

3.2 Network Model Design

This paper combined with space information network of characteristics introduced contact figure strategy describe the network topology state of network node model and link model. Space

information network of backbone network model for have to with right figure,The network topology has an arcane degeneration saidG=(V(T),E(T))WhichV(T)Representative Network with time change of Node,E(T)Representative Network with time change of edge has connectivity and link distance two properties two are timeTOf function.

4. Routing Mechanism describe4.1Routing process

This paper design of network function model contains global controller and local controller the former storage global network knowledge base basis global network topology state information generation flow table data; the latter storage monitoring range in the Network Knowledge Base, based on Local Network Topology state information generation flow table data. Accordingly, this paper design space information network of update and routing work process are as follows:

(1) Network knowledge base update process. Network knowledge base there are two kind of update style respectively for periodic update and trigger update. Update start after controller will get related network connection report.

(2) Global controller network initialization process.NCCFirst based on global network connection state data by using the much path routing strategy for network each of node between generation more article path generate flow table data alongGEO,MEO,LEOEach layer orientation to the whole network.

(3) Data Flow of transmission process. In network complete initialization process after has forwarding function of node get flow table data network start transmission data.

(4) Controller of network in sudden situation of perception, processing process. When network in sudden status when routing request information will trigger local controller perception network burst status update network connection

Then the global Controller determines the failure path based on the stored global network path data and completes the replacement of the network failure path.

4.2Stream table structure

The flow table is stored in the device of data forwarding plane, which is similar to the combination of routing table and forwarding publication and is the basis for forwarding operation. Flow table header includes3.Fields, which are matched domains, actions, and counters. Flow table item format as shown in Figure2.Shown.

(1.) Match Field

The different combinations of fields in the matching domain determine the matching granularity. The matching rules of different granularity have a direct impact on the forwarding action. The calculation formula for the primary field in the matching field is as follows.

The earliest transfer time and the last transfer time are calculated:

Among them,NowFor current time (NowPackets can only be transmitted using this path between the earliest and the most late point in time, otherwise the path expires and the transmission fails);Starttime$_{FirstLink \in Path}$The Start Communication Time for the first link that makes up the path. Late transmission time and packet failure timeExpiretime$_{Message}$The communication deadline for all links that make up the pathEndtime$_{Wang\ YiLink \in Path}$The size of the packet

Length$_{Message}$Link bandwidth consisting of pathsBandwidth$_{Wang\ YiLink \in Path}$,

Physical Propagation SpeedV$_{Transmit}$, Link distanceDistance$_{Wang\ YiLink \in Path}$And Chang

CRelated.CIndicates the upper delay limit that may be caused by the relative motion of the two satellites during the data transmission. In addition, physics

(2.) Delay

The link distance in spatial information network is long and time-varying, and the delay caused by the link distance cannot be ignored. There are many types of links, and different types of link bandwidth are different. The delay caused by bandwidth and the length of the data stream is also considered, as follows:

Distance$_{Link}$=

Type (8.)D_T,D_{Ave},D_{Max},D_{Min}Represent the instantaneous distance, average distance, maximum distance and minimum distance of the link over a period of time.

(3.) Action field

An action field is used to describe an action that is performed after a successful data match, either for an action or for an action set.

(4.) Statistics

Statistics are used to count how many data streams have successfully matched to the current stream table item.

4.3 Routing Policy

In this paperSDNIn this paper, multi-path routing algorithm and dynamic response routing algorithm are proposed based on the combination of static and dynamic. Because both routing algorithms are based onCgrAt the same time, the topological change of space information network is more complex than Deep Space Network and the algorithm time complexity is larger. In order to speed up the search speed, both algorithms have added some pruning operations. Algorithm involves variables and formulas such as table1.Shown.

Type (10) Defines the data expected delivery time variable[18]Where,

MlsrMost of the time slot intervals are distributed in2 minWithin, the number of time slots close5 000BecauseMlsrDiscretization of dynamic network topology

NA lot of time slots are generated when the relationship between groups changes frequently;Cgr_tDistribution in2 hWithin time slot quantity only a few ten a for its attention of is every article link of connected time and every article path of effective time. From source node and objective node between the transmission path to consider"MLSRNeed to experience5 000A time slot to need5 000Times routing calculation;"CGR_TThe only need to experience a few ten a time slot a few ten times routing calculation great to reduce the heavy routing of number.

50Between change when the path Delay and routing jump Number. By figure available"MLSRObtained the delay usually will BillyCGR_TGet of delay big some. But also there is a small amount ofCGR_TGeneration path of delay greaterMLSRGeneration of path Delay of situation. Reason is

CGR_TBelongs to pre-calculation Routing Mechanism in evaluation path delayed performance comprehensive consider the link of maximum propagation delay, minimum propagation delay, average propagation delay and instantaneous propagation delay, reflect of IS path valid in the path performance time slot span big andMLSRMore reflect the more of IS path of instantaneous performance time slot span small.

In addition"MLSRGeneration of path jump number of distribution have to is uniform,CGR_TGeneration of path jump number of distribution have to is dispersion. However inCGR_TGeneration of routing jump number greaterMLSRGeneration of routing jump number when delay performance but better than the latter.

(3) Data transmission overhead

Data transmission overhead is refers to from node launched communication request to all request all access after objective end point the experience of time. Here only collection of the concurrent transmission path number upper limit3When the data.

6Show that"CGR_TStrategy cost of communication time delay significantly less than"MLSRStrategy. Because at a certain time, when there are multiple communication requests between a pair of nodes, the queuing delay of communication will increase. And the delay caused by data transmission using a single path will increase with the increase of Communication Request. When data is transmitted using multiple paths, the delay will increase slowly as the number of communication requests increases.

(4.) Fault Handling overhead

7.Show adoptionCgr_quickAverage cost value for Policy100 ~ 200 MSFloating between; the total overhead gradually increases as the number of fault nodes increases. AdoptedMlsrThe average and total spending of the Strategy are flat and stable600 MS. To sum up,MlsrThe strategy is suitable for scenarios where failures occur more frequently but with less frequency.Cgr_quickIt is suitable for dealing with small number of failures.

6. Closing remarks

Based onSDNA Routing Mechanism for spatial information network is designed based on the contact graph. First, introduceSDNThe idea of separating the data plane and the control plane simplifies the on-board devices and improves the calculation ability of the route. Secondly, the routing strategy based on the contact graph is proposed to enhance the data

transmission rate and the Network Fault response ability. Among them, compared with the benchmark routing mechanism, the multi-path routing strategy designed in this paper has lower Multipath Transmission time overhead when the network load is large; dynamic Response Routing Strategy has better processing time when network failures occur in small amount and multiple times. Simulation results show that the proposed routing mechanism is feasible and effective.

The next step will focus on the further practicability of the algorithm and model. In addition, the time complexity of the routing mechanism designed in this paper will be improved after the network size is expanded, which will be an important research direction in the future.

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