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Survivable Virtual Network Mapping With Content Connectivity against Multiple Link Failures in Optical Metro Network

Ms.S.Geerthana[1], F.S.Benita[2], M.V.Brindha[2], S.Hemalatha[2]
[1]Assistant Professor, Department of Electronics and Communication Engineering, K.Ramakrishnan College of Technology, Trichy, Tamil Nadu, India
[2]Student, Department of Electronics and Communication Engineering, K.Ramakrishnan College of Technology, Trichy, Tamil Nadu, India

ABSTRACT

Network connectivity, i.e., the reachability of any network node from all other nodes, is often considered as the default network survivability metric against failures. However, in the case of a large-scale disaster disconnecting multiple network components, network connectivity may not be achievable. On the other hand, with the shifting service paradigm towards the cloud in today's networks, most services can still be provided as long as at least a content replica is available in all disconnected network partitions. The concept of content connectivity has been introduced as new network survivability metric under a large-scale disaster. Content connectivity is defined as the reachability of content from every node in a network under a specific failure scenario. In this work, we investigate how to ensure content connectivity in optical metro networks. We derive necessary and sufficient conditions and develop what we believe to be a novel mathematical formulation to map a virtual network over a physical network such that content connectivity for the virtual network is ensured against multiple link failures in the physical network. In our numerical results, obtained under various network settings, we compare the performance of mapping with content connectivity and network connectivity and show that mapping with content connectivity can guarantee higher survivability, lower network bandwidth utilization, and significant improvement of service availability

Keywords: Content connectivity, optical metro networks, data centres, survivable mapping, n–link failures

I. INTRODUCTION

Optical metro networks are gaining importance as a key segment of the telecom network infrastructure. They provide the physical substrate to enable novel network services that will shape our future society such as smart city services (e.g., smart transportation, smart energy, and smart health care) and incoming 5G services [e.g., Ultra Reliable Low Latency Services (uRLLC)]. Several of these services will require an optical metro network that allows them to fulfil extremely high availability requirements.With increasing demand for high-bandwidth and low latency services, the metro network segment is gaining more importance and functionalities. Several, especially cloud, services are now hosted directly in data centres located in the metro areas so that, in today's telecom networks, 75% of total traffic is terminated within the metro area. Reliability in metro access networks is emerging as a stringent requirement and its importance is expected to increase with adoption of ultra-reliable low latency services in 5G communications.

Since the Internet was originally designed to provide end-to end communication, Network Connectivity (NC) (i.e., reachability of every network node from all other nodes) has been traditionally used as the main metric for survivability against failures. Unfortunately, in case of disasters, multiple links may be simultaneously interrupted; and providing NC in such conditions can be very costly, or even infeasible. Also, networks are becoming more content centric. Thus, several content-based services can be provided if a content replica is available in all disconnected network portions. To model this evolving reliability requirement, Content Connectivity (CC) has been introduced as an additional metric to measure network survivability. CC is defined as the reachability of content from every node in a logical topology under failure scenarios. This metric is considered useful under large-scale failures as disasters, while NC will probably remain the default choice for smaller failure scenarios (such as single failures).

Some research on CC has already been conducted. In the authors solved the CC problem against single-link failures. In the authors extended the CC problem to double link failure scenarios. In both works, the CC problem was examined for backbone optical networks with mesh topologies. In this work, we address the more general problem of CC against n–link failures focusing on optical metro networks where the physical topology consists of interconnected rings. We aim to provide protection to a logical topology mapped over a physical optical network. Our contributions can be summarized as follows. First, we propose a problem formulation that is more scalable than the ones. By improving scalability, our work can not only cope with larger networks with a higher number of nodes and links but can also concurrently preserve problem optimality. Second, our formulation generalizes the CC problem to an arbitrary number of link failures. The motivation of this method is to better prepare networks for large-scale failure scenarios as disasters.

II. RELATED WORKS

In [1] Stefan Parkvall, Erik Dahlman, Anders Furuskär, and MattiasFrenne et al presents an overview of the technology components and capabilities of the New Radio (NR) radio interface standard currently under development by 3GPP. NR will enable new use cases, requiring further enhanced data rates, latency, coverage, capacity, and reliability. This needs to be accomplished with improved network energy performance and the ability to exploit spectrum in very high frequency bands. Key technology components to reach these targets include flexible numerology, latency-optimized frame structure, massive MIMO, interworking between high and low frequency bands, and ultra-lean transmissions. Preliminary evaluations indicate that, with these technology components, NR can reach the 5G targets. Mobile broadband (MBB) will continue to be important and drive the need for higher system capacity, better coverage, and higher data rates. However, the aim of 5G is much wider than that. One example is massive machine-type communication (mMTC), sometimes also referred to as the Internet of Things (IoT), where key challenges are to enable very low device cost and energy consumption, provide extreme coverage, and handle very large numbers of devices

In [2] MuntasirRaihan Rahman and RaoufBoutaba et al presents Network virtualization can offer more flexibility and better manageability for the future Internet by allowing multiple heterogeneous virtual networks (VN) to coexist on a shared infrastructure provider (InP) network. A major challenge in this respect is the VN embedding problem that deals with the efficient mapping of virtual resources on InP network resources. Previous research focused on heuristic algorithms for the VN embedding problem assuming that the InP network remains operational at all times. Our evaluation results show that our proposed heuristics for SVNE outperform the baseline heuristic in terms of long term business profit for the InP, acceptance ratio, bandwidth efficiency, and response time. To formulate the survivable virtual network embedding (SVNE) problem to incorporate single substrate link failures in VNE and propose an efficient heuristic for solving it. Since multiple link failures is a low probability event, we focus on single substrate link failures. In this paper, we don't explicitly deal with node failures. This is because any node failure aware virtual network embedding algorithm depends on tolerating adjacent link failures. As a result, we need to address link failures before dealing with node failures

In [3] Helder M. N. S. Oliveira, IyadKatib, Nelson L. S. da Fonseca and Deep Medhi et al presents In multilayer networks, protection can be accomplished in any of the layers. However, which layer to protect most remains an important problem. In this paper, we consider a three-layer with IP/MPLS-over-OTN-over-DWDM in which we consider an optimization modelling framework incorporating modularization of its capacity for protection in any layer. Our resulting study, conducted on two topologies, shows that the cost ratio of different layers is an important factor in answering this question, as well as the actual modular values of the capacity used. Furthermore, we found that the cost providing protection in the OTN layer is highly influenced by the network connectivity. In the impact of GMPLS on multi-layer survivability has been addressed. It noted that restoration can be well accomplished with a good balance of protection in each of the two layers by invoking dynamic routing after a failure. It may be noted that most works so far ignored the OTN layer in considering network protection. In a protection design model for three-layer networks was addressed. Mainly, the benefit of employing a protection mechanism in each layer was emphasized leading to a fully survivable and recoverable network.

In [4] ENRIQUE J. DÁVALOS, AND BENJAMÍN BARÁN et al presents An important challenge in network virtualization is the process of assigning physical resources to virtual network requests, where virtual node resources represent the demands of IT capacities while virtual links are connected between pairs of virtual nodes. Due to their special characteristics, a physical optical network infrastructure requires specific strategies to solve this problem, called virtual optical network embedding (VONE). This paper presents a survey on most relevant VONE schemes found in the literature. A discussion of important algorithmic aspects of this problem is presented, such as optical-layer restrictions, global performance metrics, and possible research directions. In addition, we propose a new taxonomy of VONE approaches, considering the type of optical networks, dynamic or static scenarios, and the optimization method. For these reasons, the provisioning of increased cloud-based services requires a high level of virtualization in data enter and networking resources. The problem of optimally mapping virtual networks over a physical network is usually named Virtual Network Embedding (VNE), and it is the main resource allocation challenge in network virtualization.

In [5] Giap Le, Andrea Marotta, SifatFerdousi, Sugang Xu, Yusuke Hirota et al presents Network connectivity has been the traditional metric for network survivability against failures. In case of a disaster, network connectivity may not always be guaranteed due to multiple link failures. With the shifting service paradigm towards cloud computing/storage, some network services can still be provided if a content replica is available in all disconnected network segments. As a result, content connectivity has been introduced as an additional metric for network survivability under disasters. Content connectivity is defined as the reachability of content from every node in a logical topology under a given failure scenario. In this work, we investigate the content-connectivity problem in optical metro networks in the case of multiple (n) link failures. We consider the problem of mapping a logical topology over an optical metro network such that every node in the logical topology can reach at least one data centre hosting the content after n–link failures. We formulate the problem as an integer linear program to minimize total network resource usage. We provide a cost comparison between content connectivity and network connectivity under typical failure scenarios. First, we propose a problem formulation that is more scalable than the ones. By improving scalability, our work can not only cope with larger networks with a higher number of nodes and links but can also concurrently preserve problem optimality

III. PROBLEM DEFINITION

In a practical situation where a virtual network requests a given target of content availability, this experiment demonstrates which the options to fulfill this requirement are. To meet a certain target of content availability, an operator has two options: 1) adding more virtual links or 2) adding more content replicas. In general, adding virtual links implies adding more network resources while adding content replicas means adding more computing/storage in data enters and network resources for synchronization. For this issue, only the operator knows which option is optimal cost-wise (i.e., it depends on the relative cost of adding a virtual link versus adding a content replica). Therefore, the decision between adding more content replicas or augmenting additional virtual links to a VN may vary from operator to operator.

IV. PROPOSED SYSTEM

It focuses our attention on how to find SVNM with CC. We investigate how to evolve the formulation of SVNM from NC to CC in the case of multiple link failures. We identify necessary and sufficient conditions to map a VN over a PN such that CC for the VN is guaranteed against multiple link (i.e., k-link) failures in the PN. Then, we use these conditions to formulate the problem of finding SVNM with CC against k-link failures as an integer linear program (ILP). We simulate various network settings and compare the performance of SVNM with CC to NC. Our numerical results show that SVNM with CC has higher survivability, particularly against a large-scale disaster; saves network bandwidth; and significantly improves service availability.

V. BLOCK DIAGRAM

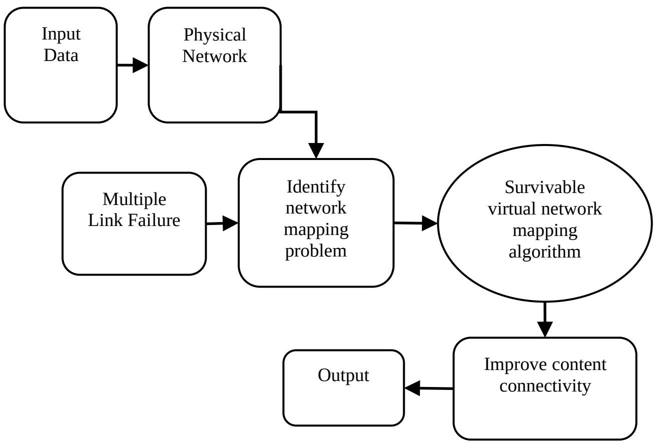

Fig Block diagram

VI. PROPOSED PROCESS EXPLANATION

Optical Network

Optical network is the fundamental part in 5G multi-domain heterogeneous network to ensure the high bandwidth and low latency transmission. Many existing works have proposed efficient VNE allocation schemes from various aspects to guarantee the converged massive 5G services performance requirements for network virtualization. A novel dynamic VNE approach based on an auxiliary graph is proposed to improve network utilization and performance by adjusting the weights of the edges of the auxiliary graph on fixed-grid DWDM network. The proposed VNE algorithms for migration in have improved network utilization and energy consumption efficiently

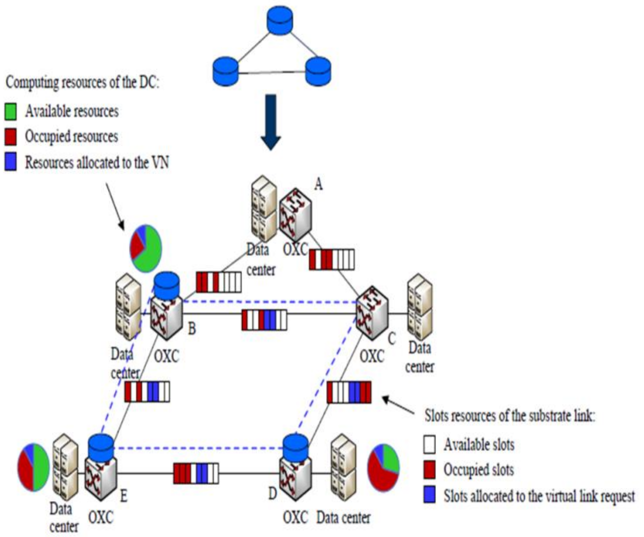

Fig virtual link request

Network virtualization

Network virtualization enables multiple virtual networks(VNs) to coexist on the same physical network dynamically,so that virtual network users can share the underlying physical network. At the same time, network virtualizationtechnology as a new technology means to provide a solutionto cloud computing diverse services. In order to relievethe interdependence between network control and data planenetwork service operators are generally divided intotwo roles: the underlying infrastructure provider (InP) andthe service provider (SP); their tasks are to deploy the underlyingnetwork resources and lease a number of underlyinginfrastructure providers to provide the underlying networkresources to meet the custom scalability of virtual networkservices

Survivability in optical networks

Survivability has critical importance for high bandwidth optical backbone networks to provide resilience against network failures. The failures in fiber-optic networks occur often due to the cable-based technology and co-located infrastructure with other network utilities. Furthermore, the transmission capacity in today's networks has largely increased in which a single optical fiber can carry over 20 Tbps traffic transmission, thus, the failures will cause huge loss for service providers and costumers

Content-centric networks

Traditional approaches to network survivability should be updated to reflect the evolving reliability requirement. In this work, we consider the evolution of the traditional survivability metric, namely network connectivity, and investigate how it can be evolved towards a new concept, called content connectivity.

Network connectivity (NC)

Network connectivity (NC) is defined as the reachabilityof any network node from all other nodes in a network.Originally, NC was used to measure network survivability inend-to-end communications and will probably remain thedefault option for a smaller failure scenario (such as a randomsingle-link/node failure). Unfortunately, in the case of alarge-scale disaster, multiple links and nodes may be simultaneouslyinterrupted, ensuring NC to be very costly, or eveninfeasible. To ensure service continuity even in such extremefailure scenarios, content connectivity can be considered as anew approach to measure network survivability

Content connectivity (CC)

Content connectivity (CC) is defined as the reachability of content from every node in a network under a certain failure scenario. The main idea is that, even if the network becomes disconnected, as long as CC is guaranteed, every user can still reach at least a content replica in all disconnected network partitions. Therefore, service continuity is guaranteed. In the context of future optical metro networks, CC and NC can be used to measure the survivability of VNs/slices. In an optical network, a VN comprises a set of virtual nodes connecting to each other using light paths (a.k.a., virtual links). The set of virtual nodes can be central offices (COs) requestinga leased VN to connect them

Link failure protection

In an optical network, each link carries many light paths, and the failure of a single link causes the failure of all the light paths traversing the link. Both link protection and path protection can be used to protect link failure.

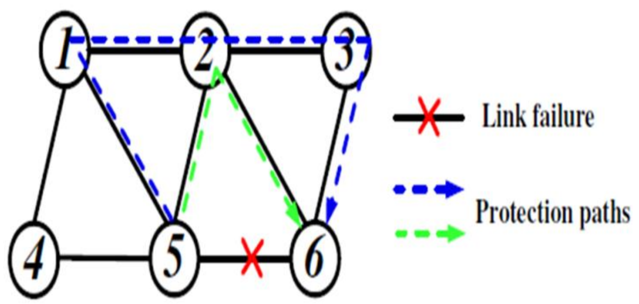

Fig Link protection

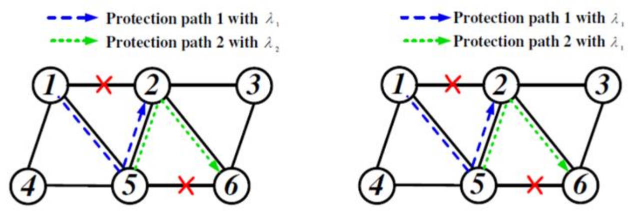

Figure Link protection against single link failure

The basic idea of link protection is that a protection path is reserved for each link, and when the link fails, traffic is rerouted around the failed link via the protection path. Link protection involves only the nodes adjacent to the failed link and switches the failed connections to the backup path around the link failure.

Mapping Problem Description

Virtual network mapping problems are generally defined as mappingwhich usually include node mapping and link mapping. The number of physical network resources is deemed. When the virtual request arrives, in the node mapping phase, the candidate physical node satisfies two conditions: (1) the number of available computing resources is greater than the amount of CPU resources required by the virtual node and (2) the physical coordinates of the physical node meet the requirements of the virtual node.

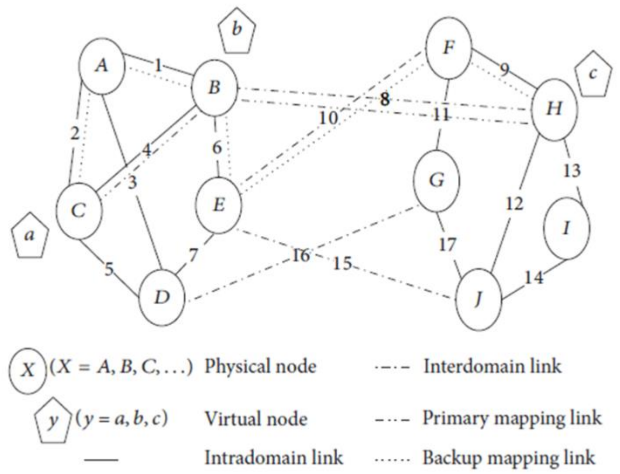

Fig Network mapping

Virtual Network Mapping With Content Connectivity against Multiple Link Failures

Our objective is to map the VN over the PN such that every virtual node can reach at least one content replica after failures on k distinct physical links. Note that, 1) since we do not provide protection in the optical layer, direct light paths from a virtual node to content replicas are not required (i.e., a virtual node can use other virtual nodes as transit nodes to reach content replicas), and 2) a virtual node hosting a content replica is CC-survivable against failures on physical links. In this context, we assume that a) the virtual node is attached to a local/co-located data enter using local (short reach) links that do not belong to the main network topology, and b) the data enter is hosting the desired content. Since we do not consider local link failures, the virtual node is CC-survivable against failures on physical links

Physical Networks

To consider optical metro networks covering an urban or metro area up to 100 km in diameter. Traditionally, optical metro networks consist of a main ring and multiple sub rings connecting together. Currently, metro networks are evolving from a rigid ring-based infrastructure to a mesh based network-and-computing ecosystem. Edge computing, i.e., a set of small, highly distributed DCs with processing and storage capabilities, is becoming popular in metro networks

Network Risk Models

Link failure probability depends on many parameters such as intensity of a disaster, distance from the disaster epicentre, intersection with the disaster zone, and frequency of construction work. Since risk modelling is not the focus of this work, in our result setting, we use information publicly available from other fields such as climatology, geology, environmental science, and construction engineering to estimate network risk.

Data Security

As the nodes are mapped in different domain sub networks, when a major accident happened in a sub network, such as earthquakes, floods, or other large natural disasters, mapping in different domain sub networks can effectively avoid the loss of data and improve the security of the data.

Virtual Network Mapping Algorithm

The implementation of this algorithm is in accordance with the order of arrival of the events. At different time points, the algorithm will deal with different events which include two types of virtual network requests: the new virtual request waits for service and the virtual request leaves after service has been completed. The algorithm flow will not be completed until all the events have been processed.this algorithm is to findthe mapping scheme in the multidomain environment andthe key is to find the physical mapping nodes distributed indifferent domain sub networks for virtual nodes on one link.Through the above mapping method, we can improve thenode data security and avoid data loss due to domain failuresand the process of finding a mapping scheme

VII. CONCLUSION

To propose what we believe to be a novel approach to map a virtual network over a physical network with content connectivity against multiple link failures. We developed necessary and sufficient conditions for the existence of survivable content-connected mapping and introduced the content cut set concept. Since the number of content cut sets is considerably smaller than the number of network cut sets, the problem formulation reduces the time required to find a survivable mapping. Therefore, we can solve various complex problem instances with a larger number of nodes and links while maintaining the solution optimality. Numerical results show that survivable virtual network mapping with content connectivity has higher survivability than survivable virtual network mapping with network connectivity, particularly against large-scale failures, saves network bandwidth, and significantly improves service availability.

VIII. REFERENCES

[1]. S. P. Mohanty, U. Choppali, and E. Kougianos, "Everything you wanted to know about smart cities: the Internet of Things is the backbone," IEEE Consum. Electron. Mag. 5(3), 60–70 (2016).

[2]. S. Parkvall, E. Dahlman, A. Furuskar, and M. Frenne, "NR: the new 5G radio access technology," IEEE Commun. Stand. Mag. 1(4), 24–30 (2017).

[3]. A. Marotta, D. Cassioli, M. Tornatore, Y. Hirota, Y. Awaji, and B. Mukherjee, "Reliable slicing with isolation in optical metroaggregation networks," in Optical Fiber Communication Conference (OFC) (2020).

[4]. J. Ordonez-Lucena, P. Ameigeiras, D. Lopez, J. J. Ramos-Munoz, J. Lorca, and J. Folgueira, "Network slicing for 5G with SDN/NFV: concepts, architectures, and challenges," IEEE Commun. Mag. 55(5), 80–87 (2017).

[5]. Cisco, "Cisco Visual Networking Index (VNI): Forecast and Trends 2017–2022," White Paper (2019). 6. M. F. Habib, M. Tornatore, and B. Mukherjee, "Fault-tolerant virtual network mapping to provide content connectivity in optical networks," in Optical Fiber Communication Conference (OFC) (2013).

[6]. B. Mukherjee, Optical WDM Networks (Springer, 2006).

[7]. E. Modiano and A. Narula-Tam, "Survivable lightpath routing: a new approach to the design of WDM-based networks," IEEE J. Sel. Areas Commun. 20, 800–809 (2002).

[8]. E. J. Dávalos and B. Barán, "A survey on algorithmic aspects of virtual optical network embedding for cloud networks," IEEE Access 6, 20893–20906 (2018).

[9]. M. R. Rahman and R. Boutaba, "SVNE: survivable virtual network embedding algorithms for network virtualization," IEEE Trans. Netw. Serv. Manage. 10, 105–118 (2013).

[10]. H. Oliveira, I. Katib, N. da Fonseca, and D. Medhi, "Comparison of network protection in three-layer IP/MPLS-over-OTN-over- DWDM networks," in IEEE Global Communications Conference (GLOBECOM) (2015).

[11]. P. Gill, N. Jain, and N. Nagappan, "Understanding network failures in data centers: measurement, analysis, and implications," in ACM SIGCOMM Conference (2011).

[12]. DC Dynamics, "Google cloud US-EAST1 data centers disrupted due to physical damage to multiple fiber bundles," Technical Report, 2019.

[13]. BBC, "Google goes offline after fibre cables cut," Technical Report, 2019.

[14]. G. Le, A. Marotta, S. Ferdousi, S. Xu, Y. Hirota, Y. Awaji, M. Tornatore, and B. Mukherjee, "Logical network mapping with content connectivity against multiple link failures in optical metro networks," in IEEE Advanced Networks and Telecom Systems Conference (ANTS) (2019).