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Article

Maintain the Communications Network From Infrastructure Failure Using A Multipath Network

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Abstract: The reliability of communication networks has become increasingly critical in data-intensive environments, where single-path systems often fail under infrastructure disruption. To address such vulnerabilities, this study investigates multi-path data transmission techniques using RIP and OSPF routing protocols within wired and wireless networks. Although various routing protocols have been compared in prior works, comprehensive analysis on the performance of OSPF and RIP in hybrid (wired and wireless) multi-path networks under simulated real-time conditions remains limited. This study aims to evaluate the efficiency of Open Shortest Path First (OSPF) and Routing Information Protocol (RIP) within a simulated multipath framework to determine the most reliable and low-delay data transmission approach. Simulation through Opnet Modeler 14.5 demonstrated that the OSPF protocol consistently outperforms RIP across several key performance metrics, including delay rate (0.00030s for OSPF vs. 0.00035s for RIP), network load distribution, and end-to-end transmission delay in video conferencing applications. Unlike traditional single-path models, the proposed design integrates concurrent wired and wireless transmission, ensuring continuous data flow even during physical path disruptions. The findings confirm OSPF's superiority in sustaining efficient, uninterrupted communication in multipath environments, suggesting its adoption in scenarios requiring high availability and minimal delay, particularly in urban or mission-critical network infrastructures.

Keywords: Multipath Network, OSPF, RIP, CMT, MTCP

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1. Introduction

Networking is the informal social exchange of information and ideas between people who share shared professions or particular interests. Communication frequently begins with a single point of agreement. Transport networks are used to broaden knowledge circles, locate career prospects in diverse industries, spread news, and transfer files relevant to certain jobs [1]. A multi-path network is defined as a couple of direct network data flows from a single source to a group of terminals simultaneously. These terminals are members of a distinct and identifiable group, each having its unique address drawn from the address space of the networking protocol in use [2].

This study covers a multi-path network that has a network based on a single wired and wireless path in the process of transferring data between two connection points. If there is an existing wired connection within the network or data transfer and the connection is cut off during the transfer process, the data will be lost. Therefore, the network is connected to Wi-Fi so that there is a wireless connection and the transfer process between them is completed and followed in two points of contact in every possible circumstance [3].

After choosing the devices and tools used between the two points in the communication process, as well as the users, the opnet modeler 14.5 simulation program is chosen to build a virtual communication network that contains 3 areas connected via routers with 10G fiber optic cables and the RIP and OSPF protocols. The objective value is 1 [4].

Related Work

It was proposed to use Synchronous Multipath Transmission (CMT) technology to connect many channels for transmission via existing network interfaces as a means of data transfer mechanisms within a multihomed network. The researchers concluded that issues with packet reordering, general delay, path binding, and out-of-order packet delivery make real-time CMT challenging to implement and evaluate. In our investigation, data is moved between college and university buildings via many networks, and various computers and routers that handle various types of image and video data and files according to certain protocols are also involved. Data transmission is made much more versatile and consistent by this separation [5]. Researchers were interested in a large number of mobile devices with heterogeneous network interfaces (4G, WiFi, and even 5G) since they connect numerous paths to provide data simultaneously. Network attacks and service interruptions have received attention, and this will certainly result in a significant amount of data being retransmitted. Highlights content-rich streaming video services and explains a parallel multi-path data transmission. The retransmission of data over the same path by standard MPTCP retransmission techniques may cause the receiver's buffer to block, the researchers found. The authors suggested effective retransmission techniques in MPTCP to send data again via an empty path. According to simulation data, the suggested retransmission technique performs better in network attacks than the standard mechanism [6].

In heterogeneous access networks, the researchers emphasized the need for ubiquitous wireless infrastructures with complementing features to pool capacity for synchronous video transmission. When delivering mobile video over heterogeneous wireless networks with multihomed terminals, MPTCP must be used. They discovered that path inconsistency needs to be addressed. The limitations of the MPTCP data retransmission mechanism in various access networks. To mimic MPTCP-based video transmission quality over multiple communication routes, researchers presented a new quality-based Multipath TCP (ADMIT) method that blends rate allocation and utility maximization-based Forward Error Correction Coding (FEC). It was suggested that high-quality mobile video be transmitted over heterogeneous wireless networks with multi-party connections using ADMIT. The results of this study encourage the adoption of data transmission techniques via multi-party wireless transmission media since a wired connection can be established in case of disconnection [7].

To increase throughput by utilizing simultaneous transmissions across several pathways and bandwidth aggregation, which is made possible by the Stream Control Transport Protocol (SCTP), the researchers were interested in mobile devices having numerous network interfaces. They found that data will be received out of order due to bandwidth variance and multipath delay and that severe application-level performance loss will result from a lack of procedures. A novel quality-compliant Concurrent Multipath Transport (CMT-QA) system is put forth that leverages SCTP for real-time video delivery in networks and FTP-like data transfer. Uneven wireless coverage. Simulations demonstrate how CMT-QA performs better than current alternatives in terms of service quality, performance, and adaptable, extremely effective data transfer. By utilizing multi-path parallel transmissions in a single bandwidth, this study inspires a new methodology to find solutions; however, new simulation processes are adopted to deliver data in real-time [8].

The increasing availability of heterogeneous IP-based wireless access technologies and the growing capabilities of mobile devices have led to the proposal of the multimedia distribution opportunity. The Transport Layer Flow Control Transport Protocol (SCTP) was used to enable multi-routing, which is the capacity to support multiple network connections on a single end-to-end link. There were two types of data transfer: simultaneous multi-path transfer using one or more paths, and single-path transfer. Various retransmission policies and parameter sets simultaneously transport the paths within the link, and suggestions are given to attain optimal outcomes for data delivery. The outcomes demonstrate enhanced multimedia content transmission over SCTP associations in single and multipath situations. The aforementioned conclusions suggest that adding a protocol with a different transfer policy, like OSPF, which transfers data via the shortest path, could improve data transfer and result in better and faster delivery [9].

2. Materials and Methods

Multipathing is a routing mechanism that uses several separate alternate paths through a network at the same time. This has the potential to provide numerous benefits, including fault tolerance, increased bandwidth, and greater security [10]. In this study, a network of 3 regions is designed, connected by routers with 10 G Fiber Optic cables, in addition to using RIP and OSPF protocols to create the closest data transmission route and create a video conference conversation between the first region and the second region through the server located in the main region and the location is Baghdad, with an area of Baghdad 10 square kilometers. This research study provides a more comprehensive comparison between RIP and OSPF protocols through different metrics (the delay rate of data transfer, the rate of its distribution and uploading on the wired and wireless network, as well as the rate of network data loss and the delay rate of transferring video from one point to another) [11]. After the comparison, the best and shortest medium is concluded as a carrier for wired and wireless communication by knowing the best protocol for this process.

2.1 Concurrent Multipath Transmission (CMT)

Packets are broadcast across numerous paths concurrently by the sender and received by the receiver from a single path or several paths using CMT technology. CMT technology uses many methods to efficiently use numerous channels. CMT technology also provides more bandwidth that can be utilized to send applications for higher-quality video streaming. These strategies have been improved to include multipath-based wireless networked video streaming [12]. CMT technology effectively exploits several channels by utilizing multiple paths. Furthermore, CMT technology provides additional bandwidth that can be used to convey applications for higher-quality video streaming. These methods have been improved to include multipath-based tactics for wireless networked video streaming. CMT technology can decrease the variability in packet losses by selecting the pathways with the lowest average packet loss rate and simultaneously delivering data packets on these paths [13].

2.2 Multipath Transmission Control Protocol (MPTCP)

Is a protocol improvement that permits the simultaneous use of many network paths between two endpoints. Historically, data transport using TCP (Transport Control Protocol) has only used one path, which may have limited performance and reliability. Because of multipath transmission control protocol (MPTCP) communication technology, a single transmission control protocol (TCP) connection can use many network paths at the same time. It will allow to transfer of identical data between two endpoints using different routes. Increasing the load capacity of an existing network connection or utilizing several channels to offer fault tolerance and redundancy might improve performance [14]. In addition to its load-balancing capabilities, MPTCP provides enhanced fault tolerance. In the event of a network

failure on one path, MPTCP may immediately switch to another path without stopping the data transfer.

By doing this, service continuity is ensured, and the impact of network failures is reduced. Is a promising transport technique that enables a multihomed device to leverage several network interfaces to transfer application data across numerous pathways at the same time. However, while using MPTCP for data transmission provides numerous and appealing benefits, it is vulnerable to network attacks. When a path within the MPTCP connection is underperforming due to an assault (e.g., a denial-of-service attack), it will surely create transmission interruptions in the stable paths, degrading application-level performance as in figure 1 [15].

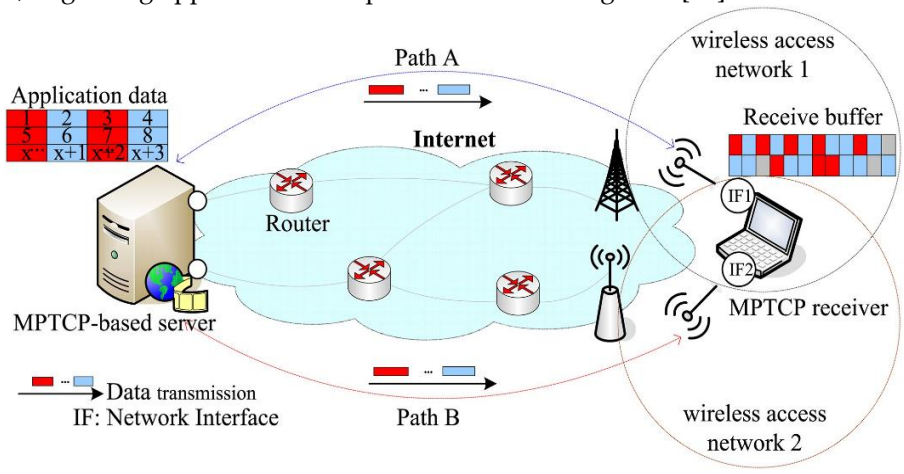

Figure 1. Data transmission in a multi-homed wireless system using MPTCP.

2.3 Open Shortest Path First (OSPF)

Considered a link-state routing protocol that finds the best route between source and destination routers using its proprietary method called Shortest Path First. The Internet Engineering Task Force (IETF) developed the Interior Gateway Protocol (IGP) protocols, including OSPF, to facilitate packet movement within a sizable autonomous system or routing domain [16].

One of a family of IP Routing protocols, the OSPF protocol serves as an Interior Gateway Protocol (IGP) for the Internet. It is used to distribute IP routing information among one Autonomous System in an IP network. Because the protocol is a link-state routing protocol, the routers exchange topology information with their nearest neighbors. Since all routers in the AS have access to the topology data, all routers in the AS have a comprehensive awareness of the AS topology. Using this representation, the end-to-end paths through the AS are then computed, usually with a variant of the Dijkstra algorithm. In a link-state routing system, the best end-to-end path to the destination is chosen to determine the next hop address that data is sent [17], see Figue 2.

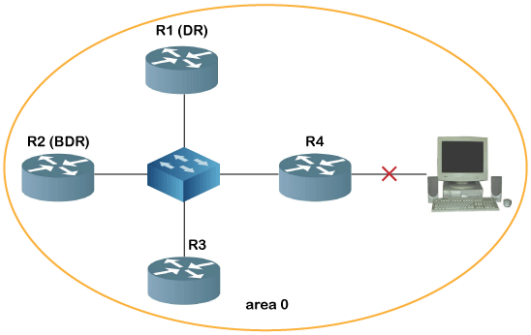

Figure 2. OSPF Protocol.

2.4 Routing Information Protocol (RIP)

Is a dynamic routing strategy that uses hop count as a routing metric to find the best path between the source and destination networks. It is a distance-vector routing protocol with an AD of 120 that runs at the Network layer of the OSI architecture. RIP makes use of the 520 port [18].

Is a distance-vector routing protocol. Routing-update messages are used by routers to update all or part of their routing tables to their neighbors when they use the distance-vector protocol. It can use RIP to configure the hosts to be a part of a RIP network. With minimal maintenance needed, this type of routing automatically reconfigures routing tables when your network changes or network connectivity breaks [19].

Network updates are sent regularly routing information (updates) are always broadcast and updates include full routing tables. Routing information received from nearby routers is always trusted by routers as is figure3 [20].

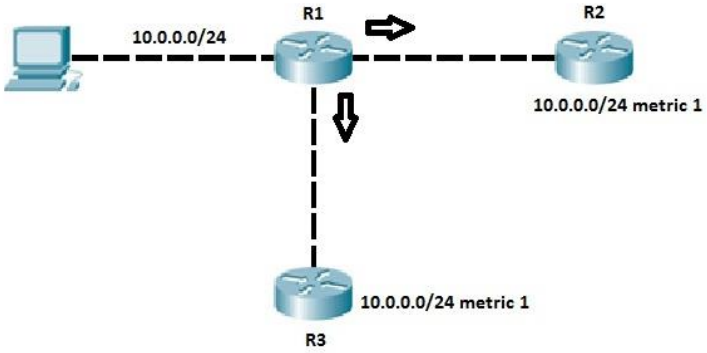

Figure 3. RIP Protocol.

3. Results

A network was created based on a single wired path if there is an existing wired connection within the network or data transfer. If the connection is disconnected during the transfer process, the data will be lost. Therefore, the network is connected to Wi-Fi so that there is a wireless connection and the transfer process is completed between two connection points. The protocols used to find the best and shortest transmission path are RIP and OSPF using the video conference server and the devices used in the communication process, the router model (Ethernet Slip8 GTWY). The wireless model is a wireless either-net router as well as a Switch giga 16 port and user computer. The communication process between the two points was simulated using the Opnet Modeler 14.5 program.

In Figure 4, the network design is shown which contains 3 regions connected by routers with 10G Fiber Optic cables and RIP and OSPF protocols. A video conference conversation is made between the first region and the second region via the server located in the main region and the virtual location, Baghdad, with an area of 10 square kilometers.

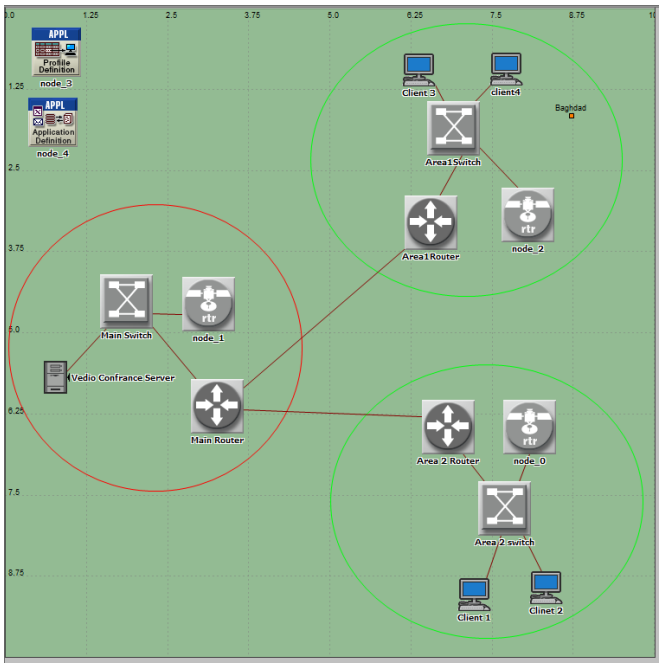

Figure 4. Network Design.

Value results were collected for both the RIP and OSPF protocols, and the values were collected based on implementation. Figure 5 shows the delay rate for data transfer via the wireless network. We note that the value of the delay rate in OSPF is 0.00030 seconds and the delay rate in RIP is 0.00035, so the delay rate in the first is the best.

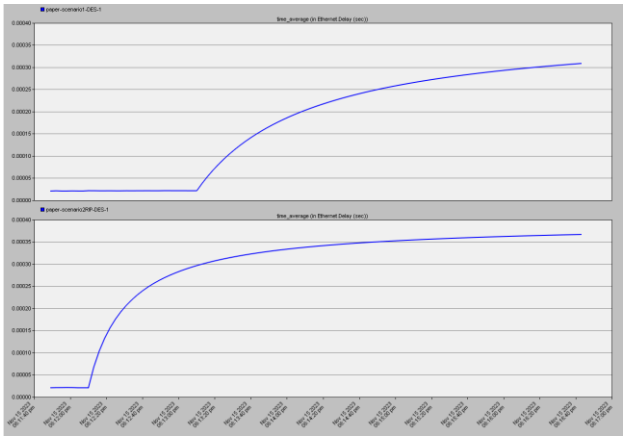

Figure 5. Either-net Network Delay.

Figure 6 shows the amount of data transferred via wireless. It was discovered that the OSPF protocol distributes data (traffic) over the available paths. It is clear that the download rate on the wireless network with the OSPF protocol is (150 bits per second), which is higher than the RIP protocol, whose rate fluctuates. From 260 to 60 bits per second.

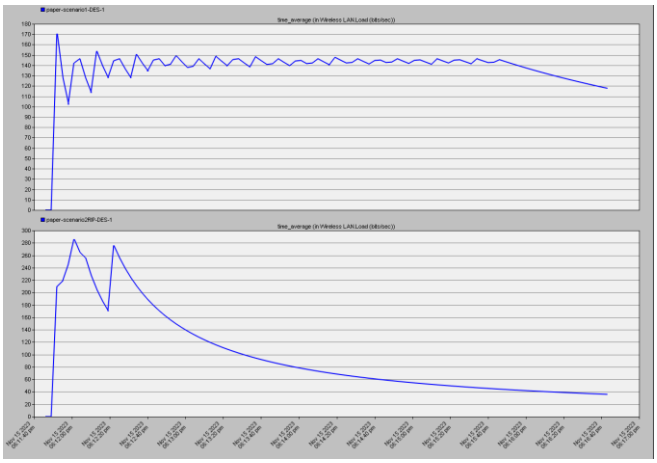

Figure 6. Wireless Lan Network Load.

Figure 7 shows the rate of network data loss in wireless communication and that there is no data loss due to multiple paths in the two proposed protocols.

Figure 7. Either Net and Wireless Data Dropped.

Figure 8 shows the video conference server either net delay. The delay rate in the OSPF protocol is 0.00055, less than the RIP, which was 0.00060.

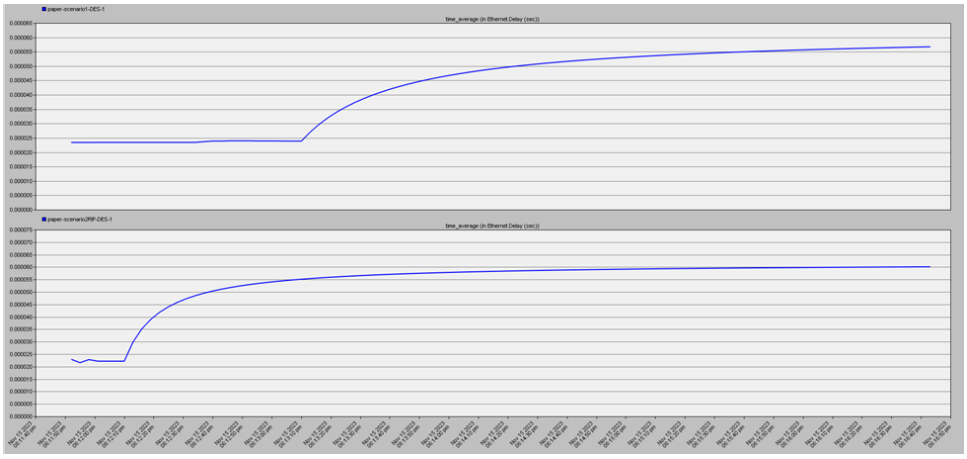

Figure 8. Video Conference Server Either Net Delay.

Figure 9 shows the delay for point-to-point video and shows that the OSPF protocol is 0.28 per second, which is less than the RIP protocol, which has a value of 0.30 per second.

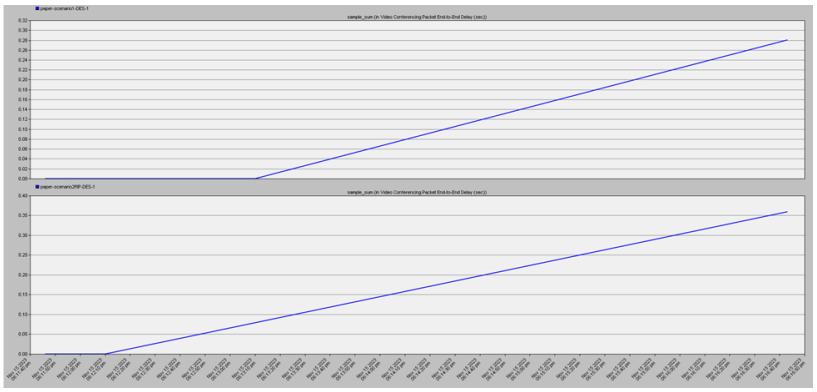

Figure 9. Video Conference Packet end to end Delay

4. Discussion

The above results show the superiority of the OSPF protocol in finding the best and shortest transmission medium, as using a multi-path network using the OSPF protocol preserves the wired and wireless network from interruption with the lowest delay rate than the RIP protocol.

5. Conclusion

From the above results, we can conclude the superiority of the OSPF protocol in finding the shortest and best transmission medium, as using a multi-path network using the OSPF protocol preserves the network, whether wired or wireless, from interruption with the lowest delay rate than the RIP protocol. It cannot be said that using the OSPF protocol, continuity of data transfer was maintained and the rate of network interruption and data loss was reduced, with users not noticing the interruption during the period of switching the communication path from wired to wireless.

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