Routing Algorithm To Reform Mobile Network Using SDN and Cloud Computing

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***Abstract*—In this project, our approach is to increase the overall functionality and range of wireless networks using Software Defined Networking and Cloud Computing. In the earlier decade, mobile devices and applications have seen critical growth and users happen to expect higher data rates and quality of service at the same time. Connections between users and services in mobile networks typically ought to pass through a required set of middleboxes. This complicated routing is one of the major stimuli for the SDN model, which permits adjustable policy-aware routing in the next-generation mobile networks. Hence, we propose an SDN based network that can be employed to develop mobile network-specific security outlines to transmit our files through the network without any loss of data and a significant reduction in overall network traffic. The goal is to handle traffic flows to maximize the aggregate measure of traffic acknowledged after some time, subject to capacity, network latency, budget, quality of service (QoS) constraints and reliability.**

***Index Terms*—Mobile Networks, Routing, Software-defined networking, Cloud Computing.**

I. Introduction

Versatile knowledge is growing rapidly and as of late takes up a bigger bit of aggregate Internet activity. When numerous portable mobile media such as cell phones, laptops and netbooks turn out to be more omnipresent, individuals utilise flexible Web as frequently as possible and have shifted a large portion of their online exercises; Including web browsing, internet money-keeping, video streaming, informal long-range connectivity, web-based gaming, from traditional satellite Internet administration to their flexible partners.

Such an unprecedented production of flexible knowledge and a vast array of online activities put a significant weight on specialist co-ops with portable network. Such bearers do not only need to overhaul their device limits as often as possible, but they do need to have separate administrations and meet the changed QoS prerequisites imposed by specific portable Internet applications. Portable systems differ considerably from established Internet Service Provider (ISP) arrangements in that they provide a distinctive tendency / direction structure, and different network elements (NE) are used for various control and information plane errands. The new 4 G LTE network uses an all-IP advanced packet core (EPC), but the network configuration is still concealed from the public Internet, so internet traffic from / to a mobile user equipment (UE) has to move through special NE like eNodeB, serving gateway (SGW), packet data network gateway (PGW), and some middle boxes in a unique way.[11]

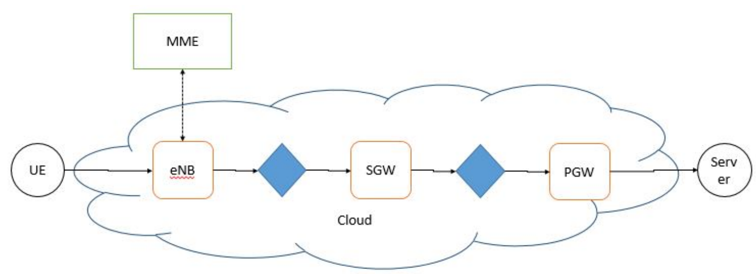

Fig. 1. Routing in 4G LTE mobile network

Typical middle boxes can provide intrusion detection and prevention for corporate customers, video streaming connexion monitoring and rate adaptation, voice-over-IP call echo cancellation, billing and charging data volume calculation, etc. Most NE are currently dynamically installed throughout the network, and the routing paths between these nodes are also pre-determined.

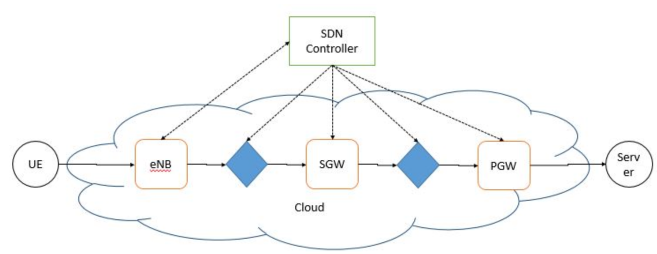

Fig. 2. Routing in a software-defined mobile network.

Mobile data traffic in current 4 G LTE networks is routed in a hop-by-hop way, either according to set routing tables or with minimal load balancing capabilities, according to 3GPP requirements. In particular, a UE selects an eNodeB based on channel measurements, the eNodeB selects a Mobility Management Entity (MME) based on region recognition (TAI) and the MME selects a PGW according to access point name (APN) and an SGW according to TAI.

The primary responsibility for QoS rests with PGW. This maps traffic flows into various QoS groups which are then converted into per-hop implemented DiffServ priorities. Because of its limited versatility when facing asymmetric traffic variability and lacking fine-grained control of network resources and end-to-end traffic steering, this approach can not completely leverage the networks to meet customers needs.[4]

A. Next Generation 5G Network

The new generation 5 G mobile network has developed traction in both academics and business over the past few years. Although the standardisation of 5 G and commercial implementations is still a few years away, there have been clearer hopes as to what 5 G will offer consumers with a range of proposals on air connectivity, fronthaul, and backhaul technologies. Among various expectations on different aspects, we pick the two that are most perceived by users: 1) Data Rate: 1Gbps to tens of Gbps peak data rate; 2) Latency: 1ms for extremely low latency use cases or at most 10ms for others.[12]

Compared to the new 4 G LTE network, the next generation 5 G network must achieve higher data rate orders of magnitude at lower latency orders of magnitude, which is quite complex and involves a rethinking of the network design. On the question of latency, we should first understand that due to physical limitations a low latency in the range of 1ms is not always achievable.Content Distribution Networks (CDN) can relay traffic to the edge of the network with static traffic such as images and videos, and can then support customers at far lower latencies within close proximity to the network. We may also build several database servers instances and data base replicas for other complex network resources and assign users to the closest one.

When we consider other considerations, such as network topologies and transmission latencies, we will require even more. The same point also refers to the gateways and middleboxes that need to be traversed across user traffic flows, since otherwise the lack of these NEs will result in triangular routing, and we have made efforts to duplicate the tools. Apart from the tight requirement of latency, the strong demand of data rate is also an significant consideration. In the last few years, the high rate of internet traffic has undergone unprecedented growth and this phenomenon will continue to bring more burdens on mobile network networks. Good strides were made and new innovations were introduced to improve the efficiency of the network. However, because network infrastructures are often statically deployed and cannot easily adapt to varying demands, traffic engineering and network scheduling are still key to high performance.[12] On the other hand, as we multiply capital and add more NE to reach a lower latency, the network's throughput (the volume of traffic transmitted in unit time from source to destination) can be improved simultaneously. When user requests are met more directly, traffic flows can travel through a reduced portion of routers and backbone links, effectively reducing the pressure on the network load and increases the amount of traffic that can be sustained.[2]

B. . Routing Algorithms Taken for comparison are as follows:

[1] PdCsp: end-to-end primal-dual constrained shortest-path routing. It is the proposed efficient online algorithm that is conscious of bandwidth variations and follows the primary dual approach to assign link lengths and perform the shortest path routing, which is restricted to end-to-end latency.

[2] Sp: end-to-end shortest-path routing. This algorithm is an improved version of PhSp that is per-hop shortest path routing algorithm which uses the graph layering technique to find the shortest end-to-end path instead of hop-by-hop connecting shortest route segments.Moreover it Sets the cost metric of each link to be inversely proportional to the bandwidth efficiency of that link and runs Dijkstra's Algorithm to find the shortest path dependent on the cost metric. This approach is also used in Open Shortest Path First (OSPF)

[3] Ml: end-to-end minimum-latency routing algorithm. This works in a similar manner to Sp except that we are now trying to find an end-to-end path with the lowest network latency rather than the number of links that make up the path.

II. METHODOLOGY

A. Architecture

The following figure 3 shows the overall architecture of simulation: firstly a network was established for simulation and SDN was created to prevent complex routing. in this case first the user needs to load the file and send it to the router.then when the file is received SDN divides the file into number of packets and which is further received by the router.if no significant loss is found then the packets are compiled together and the file is being stored

B. Software Defined Mobile Network and Cloud Computing

The stringent network latency limitations on 5G network systems call for broad replications of assets and network elements (NE) which thus add more weights to organize limit and make traffic directing more convoluted. Complex routing is one of the real stimulus for SDN, and the high expenses of flexible asset/NE replications extraordinarily benefit from cloud computing. We considered a SDN structure with cloud computing to address the difficulties of cutting edge mobile networks.

The initial intent was the managing of wired networks. Nevertheless, quite quickly it became clear that SDN would still offer tremendous benefits to the wireless environment. Future 5 G architecture planners found that separating user and control planes by SDN would enhance the network's versatility, reconfigurability and programmability, as well as multi-tenancy and effective multi-service assistance. Although

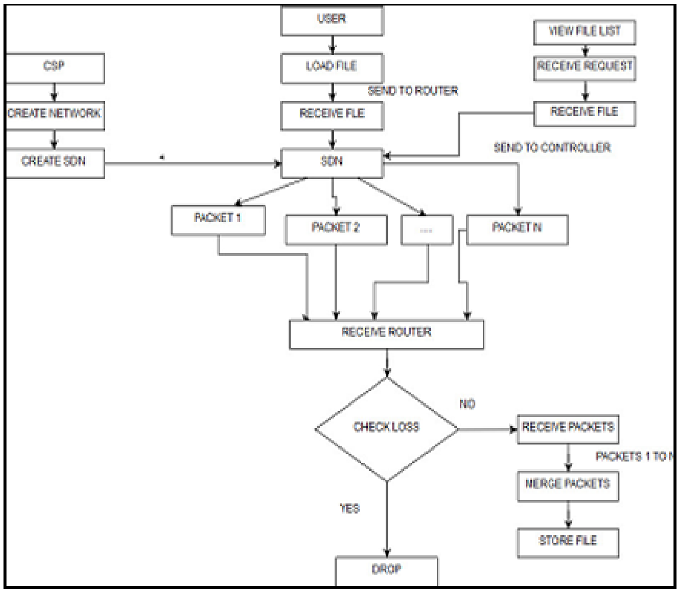

Fig. 3. Architecture for simulation

it has been expected that incorporating SDN principles in wireless and cellular settings has been a major challenge, several recent work activities indicate some promising results in this direction.[3]

Furthermore, SDN has four main advances over the existing traditional networks:

1. SDN eliminates control functionality (e.g., routers and switches) from network equipment. All the computers on the network have been basic components of forwarding.

2. In an external and central device called SDN controller or Network Operating System (NOS), which is a programme running on a computer, SDN puts control logic in. It gets the global view of the network and makes the routing decisions appropriate for the basic forwarding devices [8].

3. SDN makes routing decisions by flow1 while conventional IP routing is focused on endpoint. SDN then positions in the defined direction equivalent policies on the forwarding machines, such that each packet of the flow receives compatible services. SDN's flow-based programming technology offers exceptional versatility in network management [7].

4. SDN makes many different features simple to build by running modern software on top of an SDN server. These programmes clearly obtain from the SDN controller an explicit view of the network (ANV). They communicate with the underlying data plane via SDN controller, which maps higher-level policy decisions to lower level forwarding decisions, while making the necessary policy decisions. It is described as the most important innovation of SDN [7].

In a SDN, the control plane and the information plane are decoupled, which takes into consideration brought together routing choices and disseminated packet sending. The control plane of the system is accumulated in a SDN controller, which communicates with the switches utilizing a standard interface like Open Flow. Regularly, an uncommon demand or the first packet is sent to the SDN controller for each new flow and the following operations are performed[2][4]:

1) Policy Lookup: The policy table at the controller deter mines the logical sequence of NE that the packets in the flow have to pass to satisfy the policy requirement.

2) Flow Steering: The SDN controller maps this logical sequence of NE into the physical network according to certain QoS requirements and optimization criteria.

3) Route Installation: Once this logical path is mapped into the physical path, the SDN controller makes changes in the forwarding table on all the routers in the path so that all packets in the flow are routed along the desired path

In SDN, network devices perform a basic function as packet forwarding, whereas knowledge or control logics are applied in the controller. SDN will also increase the versatility of network delivery and system performance, as well as the stability of network control functions and equipment. OpenFlow is an open routing interface that allows researchers to apply the SDN model together with the current network.

Figure 4 demonstrates the OpenFlow SDN, which includes an OpenFlow controller to render flow decisions for OpenFlow switches. Open Flow SDN distinguishes the control plane (routing decision) from the data plane (packet forwarding), all of which are related by the OpenFlow protocol. OpenFlow controller handles basic network functions by controlling the OpenFlow transfer flow array. Like the details in the flow chart, incoming packets may be redirected to each OpenFlow transfer. The flow table in the OpenFlow switch is used to log the flow entries for the corresponding action commands, which can be dynamically inserted and deleted depending on the OpenFlow controller order. Therefore, the network topology and the state of the whole network can also be controlled by the OpenFlow controller[13].

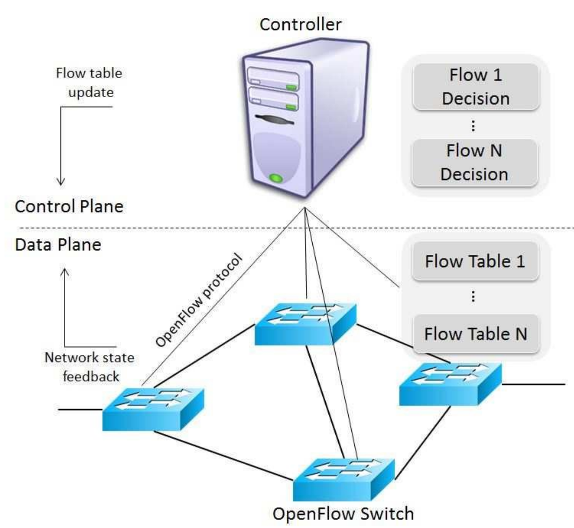

Fig. 4. System architecture of openFlow SDN

C. Controllers in SDN

In this section, we first explain three control models of SDN which are Centralized, Hierarchical, and Flat.

1. Centralized: Control plane is initially built based on a unified approach where, as shown, one controller obtains a global vision of the network and takes all control decisions. While this design could be acceptable in small-scale networks, it would have significant drawbacks as it creates a single point of failure and a performance bottle neck for the network. In order to avoid a single point of failure, we can use backup controllers. As a matter of fact, to be able to back up state details to another controller, OpenFlow requires connexions from several controllers to a switch But, we do need to tackle the issue of bottleneck efficiency and other drawbacks of a single unified controller. To address these drawbacks, researchers have introduced hierarchical and flat management structures that we will explore next.[7][8]

2. Hierarchical: There are at least two layers of power in the hierarchical strategy. At the bottom level, we have several local controls, and at the top stage, we have a single system. Local controllers respond more rapidly and provide data path resources for requests that need only local network state details. They move only requests that need a global view of the network to a localised controller. This approach reduces overload on the centralized controller; but it still has the single failure of point problem. [8]

3. Flat: There are also physically dispersed controls in Flat Approach that function in a theoretically organised manner. Such operators use their local view to set up their own domain routes. They do, therefore, share their knowledge with each other in order to cope with pathways spanning several domains. Consequently, this strategy has a benefit because it reduces the overhead of the procedure when considering single centralized controller.[7]

D. Cloud computing

Cloud computing can be used to scale the central controller in the SDN framework, which is computation intensive and could be a bottleneck as well. Instead of using a single super-scheduler to perform all the resource scheduling and traffic engineering, we can distribute these tasks to many different servers if parallelism could be exploited from the routing algorithm.[5][10]

in addition to that cloud computing can also be used for providing or delivering services over Internet. With the use of cloud, we can set up virtual infrastructure and these infrastructure can be mobile. This Cloud computing services can be public or private depending upon the service provided by organization. There are three types of cloud computing architecture: a) Software as a service b) Infrastructure as service c) Platform as service.Mostly infrastructure as a service is better for networking,[3]

Resource virtualization through data centers should be taken into account when making allocation decisions, as virtualized resources have different costs and limitations from the dedicated ones we are familiar with

E. Generic Log-Competitive Online Routing Algorithm

A generic log-competitive online routing algorithm handles flow allocations in real-time. The reason behind considering this algorithm is that highly congested links will accumulate larger lengths and thus are less likely to be further utilized when performing shortest path routing for future traffic flows. In this way, mobile traffic can be steered throughout the network rather than limited to random hotspot areas. Meanwhile, each individual flow is still allocated onto a short path, consuming as few resources as possible while avoiding congestion in the network.We considered a generic mobile network represented by a directed graph G (V, E), where V denotes a set of n nodes making up the network, and E denotes a set of m directed links connecting the nodes. The node set V contains standard routers and special NE attached to routers, including gateways, middle boxes, data centers, etc.

Each mobile traffic flow enters the network at its ingress node and has to visit a set of NE in a specified order before leaving the network at its egress node. Let us denote s be the ingress node for flow d, t be the egress node, and k be the number of NE that flow d needs to traverse. A key step in the generic online routing algorithm involves computation of the shortest path from s to the t for each flow d. As there are multiple instances of each NE, part of the optimization is to determine which NE to route through.

III. RESULTS

To develop the effectiveness of the proposed algorithms a mobile network system and some traffic streams for simulation with the end goal to reflect genuine latencies, we dynamic the bordering United States an area as a 2800mi×1500mi rectangular plane, and convey network nodes and links on this plane. We first develop a backbone network with 20 backbone routers and 30 backbone links. The performance of the baseline Sp algorithm is always lower than others in this simulation.

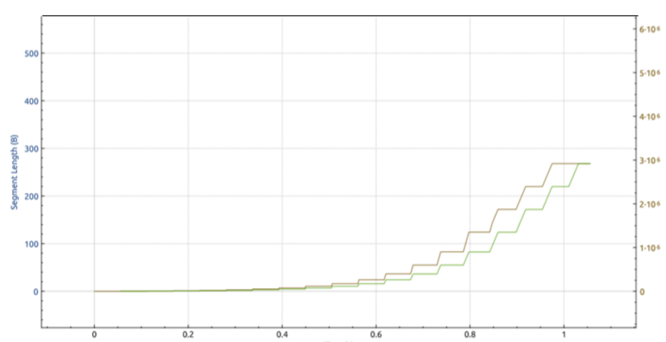

Fig. 5. Throughput for Ml and Sp Algorithms

Ml performs better in this simulation because it seeks the minimize the latency for each flow so that more flows can meet the latency constraints. Implemented Primal-dual shortest path routing algorithm outperforms other alternative routing

PARAMETERS USED	VALUES
Simulation Period T	100
number_backbone_routers	20
number_clients	10
number_switch	1
number_server	1
number_backbone_links	30
capacity_backbone_links	40Gbps
capacity_auxillary_links	10Gbps
time_delay	2ms

Fig. 6. Simulation Metrics

algorithms under NE density, latency, budget constraints, congestion control and reliability.in addition to that we had ten clients,twenty routers,one switch and server considered for simulation.Also we have implemented SDN class that accepts different algorithms handler that is each time while sending the data packet the sender needs to refer to the SDN class in order to get the route to the required destination. we implemented the proposed algorithm PdCsp by making use of the LAN network in case of simulaation.All the clients were connected to a switch via CSMA.Moreover a point-to-point connection was created between router-to-router and router-to-switch.

These backbone nodes are haphazardly put and connected however we guarantee that the entire system is associated. The backbone links are allotted a uniform limit of 40Gbps, which relates with the OC-768 fiber connects that were sent by ATT around 2008.

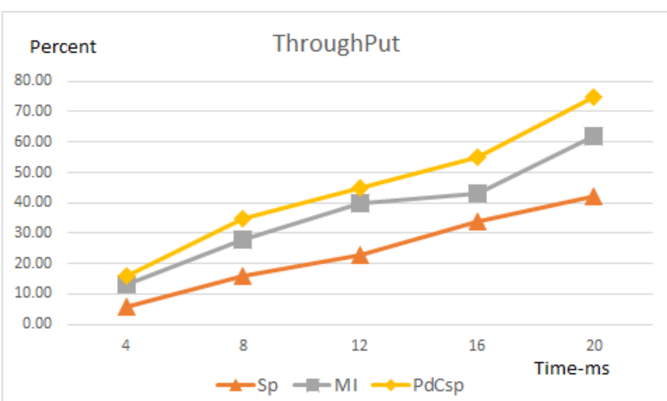

Fig. 7. Comparison of different routing algorithms on basis of throughput

Despite backbone system, the system idleness of a connection is approximated as the geographical distance between the two end nodes isolated by the speed of light in fiber. From that point forward, 2000 traffic flows are produced with

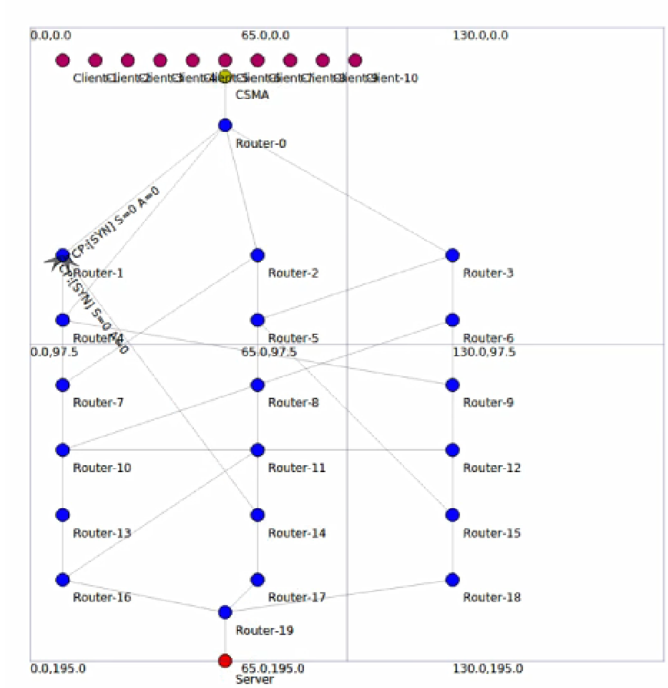

Fig. 8. Visualization of SDN simulation

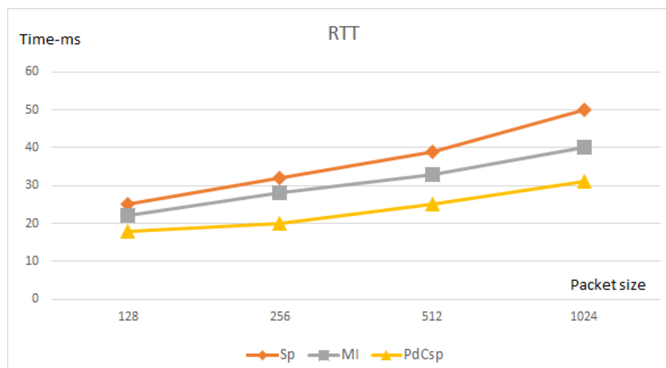

Fig. 9. Comparison of different routing algorithms on basis of RTT

arbitrary beginning/ending schedule slots, UE/resource nodes, and transmission capacities among 1Mbps and 1Gbps. Each traffic flow has just a single UE node, yet may have numerous resource nodes to represent CDN or geographical distribution of resources.

In Experiment I, we expect that all UE-created traffic flows need to cross through a SGW what's more, a PGW before achieving the server. These UE, SGW, PGW, and server nodes are arbitrarily joined to backbone and WAN nodes.As shown in the below mentioned graphs, we have generated the simulation results of the three explained routing algorithms and combined their results on the basis of throughput,round trip time(RTT) and delay bounds.

The figure 7 depicts that there was decent increase in throughput of all three given algorithm. However after 20 second PdCsp had almost 78 percent where Sp Had the least

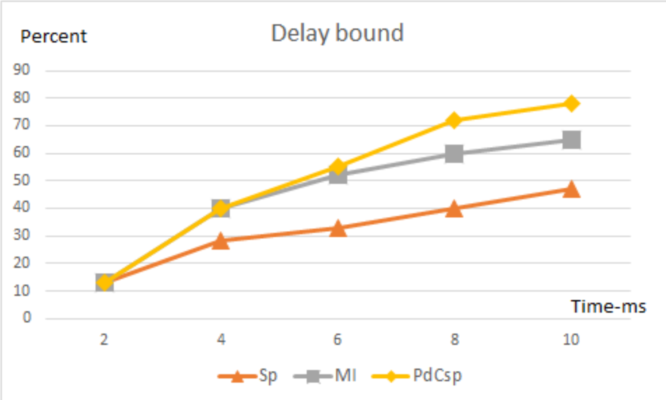

Fig. 10. Comparison of different routing algorithms on basis of delay bound

throughput which was just above the 50 percent.

The figure 8 shows the overall visualization of the SDN simulation which was done on network simulator version 3.it depicts the overall 32 nodes which we had considered for the simulation process and other backbone links.

The study of Round Trip Time(RTT) from the figure 9 reveals the fact that the impacts of the packet size increasing is negligible in PdCsp and Ml; however, it is almost two-fold in case of Sp. Referencing to figure 9 the low performance of the Sp is still considerable. Above 50 percents of the packages have not received to destination on the time that SDN predicted. When it shows 80 percent accuracy of prediction in PdCsp.

IV. CONCLUSION

SDN-based architecture with cloud computing ease steering traffic flows in a cellular network to maximize the total amount of traffic accepted over time.

Results of simulation show that end-to-end primal dual constrained shortest path routing algorithm(PdCsp) outperforms other alternative algorithms under considerations of NE density, latency, budget constraints, congestion control and reliability, hence better data speed and improved Quality of service.These results also show that due to end-to-end optimization, congestion / budget awareness, and primal-dual approximation, our proposed algorithm significantly outperforms prevalent heuristics.

Evaluation Basis	Sp	Ml	PdCsp
NE Density	✓	✓	✓
Network Latency	×	✓	✓
Budget Constraints	×	×	✓
Congestion Control	×	×	✓
Reliability	×	×	✓

Fig. 11. Comparison of different routing algorithms

Despite the low performance of the end-to-end shortest path routing algorithm (Sp) with respect to the other two routing algorithms, the other notable drawback that it uses graphs to find the shortest number of nodes to destination. However, even with the small change or modification in network it is required to regenerate the routing graph which is needed a lot of resources in form of hardware and time.

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