Fractal-Cell Smart Topology Bandwidth Allocation Model (FAST-BAM)

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Abstract

IPv6 address data could be providing research and submissions for the next generation network for video conferencing, online gaming, and live streaming. It is important to achieving higher efficiency and reliability of the network to provide the best-effort path as well as fast data transmission between nodes to the node. Network topology takes a perilous outcome no its dependability and efficiency over the network protocols. According to the complexities of the network, how a secure and productive network can be built a topological model based on the software approach is the captivating and substantial experiments. We proposed a network model that is inspired by the multi-scale model based on the fractal-cell network, has operational cell correspondence with primeval structure and progresses a model that provides dynamic topology link switching called FAST-BAM. Our network model equated with prevailing approaches and accomplishment on real network demonstration that our suggested technique operative over the SAM, MAM, RDM.

Keywords: *IPv6, GNS3, ROUTING PROTOCOLS, NETWORK TOPOLOGIES, and NGN, OSPF, RIP, EIGRP, RDM.*

I. Introduction

A sort of main could be the next generation network (NGN). Architectural changes in the core of telecommunications and communication networks. The large concept and behind NGN is that one network holds both information and services (voice, data, video) by summarizing them into IP packets, that are close to those that are used on the internet. The Internet protocol is commonly used by NGNs, such that the word all IP is used often to refer to the adjustment of the former telephone-cantered networks of the NGN technology. In the engineering systems, such as the Manu faction system, communication structures, and intelligent circulation flow schemes, numerous varied amenities are unified into a next-generation network scheme through IT, which determination outcome in a large scale of modules. These next-generation network opposite by original challenge, a complication of networks arise as of the massive quantity of components & connection in components. The latest movements have seen to build the optimal bandwidth (gaming, live streaming, transaction, and file transfer) supervision has to turn out to be the main dreads for both the telecommunications industry and therefore the scholars. Throughout the next-generation network (NGN) the quality of services (QoS) proved important. Several procedures have been planned for active bandwidth organizations, however, giving the implored standard (QoS) to the user and providing the network infrastructure to providers. The intelligent model allocation (SAM), use to beat the limitation of the previous model dynamic allocation of a bandwidth problem, As the max assignment model (MAM) does, the bandwidth between both the various flows are allocated fixedly and fully. Midst the main restrictions is that the unproductive manipulation of the Link resources that indicate that their bandwidth cannot be quickly recovered to another when no current is present. The Russian Doll Model (RDM) enables this edge to be precise and helps the flow to be distributed bandwidth to the gain of alternate lines. With the absence of this allocation, it is often only possible to allow a low priority stream, but the Smart allocation model cannot be applied within the network or involve the deliberation of certain flow parameters such as latency, rejection rate, or retransmission. Within the above model were defined as the criteria at the network layer, where the various perimeter was taken and define a different matrix. When the dynamic bandwidth allocation model worked, its

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only profileefficiency but not the reliability of the network where the different sort of node have different bandwidth allocation capacity and also predefine the utmost segment size of the packet, after providing the smart bandwidth to links, links also follow the smart topological network that reducesthe congestion over the road and supply fast, efficient, reliable data transmission over the core network. During this scenario, we provide the Fractal- Cell smart Topology Bandwidth Allocation Model that overcome the road utilization, higher throughput, low RTT, negligible delay. The FAST-BAM is based on the 2 main concepts of subsequent-generation network, like Routing protocols and Topology, these two aspects provide the entire range of network characteristics. In this phenomenon, their Efficiency supported the routing protocol and therefore the Reliability supported dynamic topology convergence over the working network. Within the fractal-cell concept the fractal-cell supported this fractal-cell separation and variation, we discover the fractal topology has structure likeness with its primeval the network reliability system and thus the primeval structure has a major effect. This paper has a concise influence as following:

- Centered on fractal-cell growth prototypical and graph theory, we proposed a smart topology fractal-cell network experimental model based on the simulation presenting a real scenario of the next-generation network. The smart topology will create a new topological network structure "We find that the primitive structure genetically defines the topologic characteristics of a fractal cell network across the topological system." [1].
- Centered on the operational correspondence of network topology by We develop a model for fractal cell networks (FAST-BAM) based on real-time simulation to define a more reliable and efficient network model with dynamic topology changing.
- This model applied any situations where the large core network requirement fast line switching and minimum chances for network failure due to congestion, delay, heavy traffic. And provide more efficiency to both layer 2 and layer 3 protocols when The MTU and MSS segment maximum units are set to also be fixed.

"The dynamic distribution one of the main network and connectivity issues challenges is the bandwidth. For the layout proposed, the bandwidth and topological relation use can be equally divided between various flows for specific priorities. Sometime over the next computer network generation, the proposed model is tied"[2]. This should be found across the industry's central network. The suggested example can be established by a controller, which enables a Network Alliance Researchers in the Software to improve their network performance.

II. Network dependability problem centered on graph theory

Permit G (V, E) be a target framework with hubs assortment, V = {VI}, I = 1, 2, 3, 4, 5, 6…….. N and a limit set, E = {et}, j = 1, 2, M. A Trail L in the two vi and VJ hubs is a complete request of hubs and progressive edges denied of emphases, and the separation between any two hubs is the most reduced number of trail edges between the two hubs. A GK organizes which speaks to a subgroup of K $\subset$V of hubs in the G arrange is connected if a course exists among explicit hubs. |K|-terminal trustworthiness of system G, spoke to by R(GK), is the probability that GK is related, where hubs and edges of system G can bomb measurably confidently with known probabilities Rvi, Rej, correspondingly. The |K|-terminal The issue of toughness is the R(GK) code issue. The 2-terminals issue is two critical unique instances of this issue of system unwavering quality where |K| = 2 and the all-terminal issue wherein K is set for the whole hub. As |K|-The unwavering quality issue has explicit highlights, and we can simply consider the entire dependability of the framework for effortlessness [1].

III. Reverse Renormalization Scheme for Fractal Network Progression

The arrangement of the multifaceted system in nature was actuated by a multifaceted renormalization process. "The strategy of resetting with the coating algorithm is the use of Network tiling of side display boxes ℓ B for the shortest distance between the nodes inside a box and the specified ℓ B to be linked to all nodes" (1). Each box can be shared with an S-node (or renormalization node) after the technique of reorganization, and two S-nodes can be paired if the

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boxes have at least one edge. Once again it is practical and often the renormalization strategy awaits a single node. The following calculation may be used to determine the self-similarity. [1]:

$$(N_B(\ell_B)/N) \sim \ell^{-d_B}_B, \quad (1)$$

$$(k_B(\ell_B)/k_{hub}) \sim \ell^{-D_K}_B, \quad (2)$$

Where *NB(ℓB)* signifies the Number of boxes, k-hub tags each box with the full number of degrees, *kB(ℓB)* denotes the degree of supernode, dB and DKis the Box degree and fractal measurement, correspondingly.Aimed at the multifaceted networks' fractal assets. A fractal growth network model cantered on the recursive relations was proposed which cantered on reversal reform.

$$\tilde{V}(t) = n\tilde{V}(t-1), \quad (3)$$

$$\tilde{k}(t) = s\tilde{k}(t-1), \quad (4)$$

$$\tilde{D}(t) + D_0 = a(\tilde{D}(t-1) + D_0), \quad (5)$$

Where $\tilde{V}(t)$ is the quantities of organize hubs t, $\tilde{k}(t)$ is age level of hubs t, $\tilde{D}$ is the system's distance across" [5]. "D0 is a trademark length, $n \geq 1$, $s \geq 1$, $a \geq 1$ is constants" [1].

In fig.1.Starting from a primitive structure G0. "Each node in the next generation with t = 0 is called supernode. The increasing supernode is then extended to a star system by inserting s = 2 new nodes to a supernode. We have to adjust each edge of the t-to-0 to connect between both the two nodes linked to t-generation edge endpoints t = 1"to guarantee network self-similarity. [1].

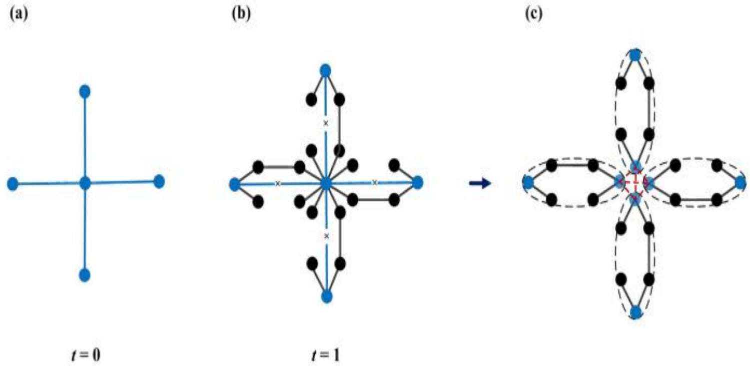

Figure 1. Inverse Regeneration Scheme Model.

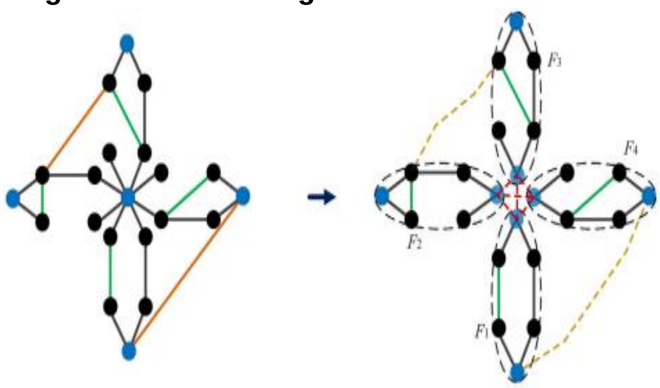

Fig. 2. All Types of Associates in Fractal Network G (F) Between Fractal Cells.

IV. Fractal-cell Network Dependability Examination

To approximate the $G^{(F)}$fractal net of the supposed $G^{(V, E)}$ network, we are researching that two forms of stimuli occur in the first one is the correlation of the node, the two fractal cells, the link of the F1 to the F2 fractal cells, the connecting node. in Fig. 2; the other edge connecting each are linked by an edge, Such as illustration the connection in Fig between F2 and F3 fractal cells. 2. If the network $G^{(F)}$ does not have fractal cell sculpting loops, the network $G^{(F)}$ is linked to nodes only. For the $G^{(F)}$ network, fractal cells and node contacts are self-contained. While a $G^{(F)}$ network of fractal cells that are stripped of loop model fractal cells is easily defined as a fractal cell tree that has the same probability of the network connecting all fractal cells all-terminal reliability. The cell rings improve the terminal dependability in the $G^{(F)}$ network Fractal cell-molded loops. It was like the cell

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circuit includes redundancies. This means that any fractal cell-associated to the relation of these cell loops is not essential. A network of cell loops is formed from a primeval loop framework through the process of growing fractal-cell separation. Therefore, if there is no amplitude of each loop, at most one edge of each loop, the primordial structure with loops cannot previously be linked; otherwise,the loss is at most one edge of each loop and the associated primordial structure may only be adequate. Consequently, when the following two circumstances grasp the G $^{(F)}$ network The G $^{(F)}$ network is linked with fractal cells and node connections:

- "Connected to the span of fractal cells, not in any cell loop
- A semi-connected cell loop at most to a fractal cell, with which the non-center nodes in a fractal cell are linked to only a center node, and their connections between other fractal cells.

It is also noted that there is often a normal edge relation between two fractal cells. Their function in terminal reliability of edge connections is equivalent in a loop created by these edges to the edge connections of the G (F) network, which enhanced the reliability of these fractal cells. While we have achieved before'[1]. The following relations may be used by this correspondence kin:

$R_{ej} = \mu j R_{ej}$, j = 1, 2, . . . ,η (6)

$R_{el} = \lambda j R_{ej}$, (7)

$\Lambda = \sum \eta\ j\ \lambda j + 1 - \eta R_{el}$, (8)

$\mu j = \Lambda\ 1 - R_{ej}\ \chi$ (9)

$\chi = \sum \eta\ j\ (1 - R_{ej})$. (10)

Where R_{ej} is the dependability of jth edge in a trail L as well as η edges, R_{el} is going to connect to the endpoint of Trail L the reliability of edge to make a loop.

V. Reliability-Based Network Topology Design

We first select the number N0, M0 of nodes, and borders in primeval structures to construct a coherent network with the expected numeral N, M of nodes & borders accordingly. We may infer from the process for the fractal-cell separation,

M = (2s + 1)tM0+☐, (11)

N = (2s + 1)tM0 − M0 + N0, (12)

Where t implies the repeat of fractal cell development, ☐ indicates the determined number of alternate ways across fractal cell decent variety into the system. [5].

VI. Protocols Matrices Calculation for Best Path Selection

In the formalization of best-path selection, we provide the Bandwidth, Reliability, load Balancing factor to calculate the survival of the best path over the topology, this formula is based on the regular matrix calculation of the routing protocols. In the network, the node, end devices, and the edges are likely connected in the manner of static connectivity that will not provide the highest efficiency and will not reliable when a higher rate of traffic will generate at that time we required a combination of both routing protocol as well as topological architecture [4].

6.1. Binding It As one—Key Values of k

We recognized that the Enhanced Interior Gateway Routing Protocol (EIGRP)customs four features to oversee its metric. And how is it calculated by these beliefs? It uses the following method of metric calculation:

$$\text{Metric} = [K_1 * b + (K_2 * b) / (256 - l) + K_3 * d] * [K_4 / (r + K_5)] \quad (13)$$

Where b as bandwidth, l as load, d as delay, r as reliability.

In this estimate, data transmission is 256 * 107/min transfer speed in the path (in kilobits), while obstruction is 256 * all out of the considerable number of delays in an association (expressed in 10 microseconds) in the lattice way. Such K esteems work as constant qualities (0 and 255). The Standard Values for EIGRP as K_1 = 1. K_2=0. K_3=1; K_4=0 & K5=0.The limit is K1 = 1. When using these default values, we have to shorten the process:

$$\text{Metric} = [1 * b + (0) / (256 - l) + 1 * d] * [0 / (r + 0)] = b + d * 0 \quad (14)$$

Where b as bandwidth, l as load, das delay, r as reliability.

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Preferably, this must be zero, but there is an admonition here. Metric of enhanced interior gateway routing (EIGRP) disregards the consistency segment when $K_5 = 0$. So, when $K_5 = 0$, the EIGRP method turns out to be:

$$\text{Metric} = [K_1 * b + (K_2 * b) / (256 - l) + K_3 * d] \quad (15)$$

Where b as bandwidth, l as load, d as delay, r as reliability.
Relieving default values for K_1 (1), K_2 (0), and K_3 (1) gives us:

$$M = B + D \quad (16)$$

M= metric, B= bandwidth, D= delay

And this will be mean to:

$$\text{Metric} = 2^8 * [107/B\ (\text{kilobits}) + D(10s\ \text{of ms})] \quad (17)$$

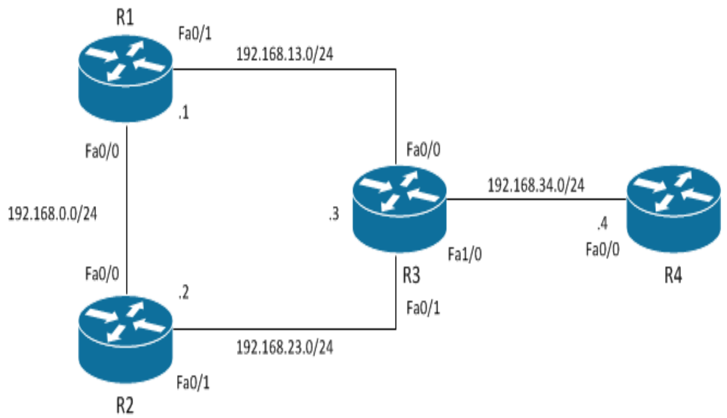

Figure 3. Test Topology Connection with Single Fractal Cell Network, Calculate Matrices

VI. Simulation Using GNS3

To assurance a sensible examination of network methods, an imitation resolution (GNS3) are going to be measured, which in distinction to the results stated beyond isn't supported distinct incident simulation, nonetheless is in a position to rival images of actual prevailing routers from diverse industrialists & to put on posh network design. A distributed process & the integration of replicated topology at device nodes in the FOKUS high-performance cluster allows massive network structures to be built and simulated. Given the reality that the accessibility of GNS3 stands out and allows us to introduce and customize superior networks following other resolutions, GNS3 does not show how knowledge packets may be driven in a network. This function is manytimes tested by the Wire Shark Machine, but the motion is not optimally demonstrated by other simulation methods. To order to imagine movement modes and trends, the clean simulation techniques indicate more innovative promise which can be extended seamlessly to the concept of discrete simulated activities. "To check viability, safety, management complexity, and availability in layouts of new IPv6 networks, for example, emulation tools like GNS3, are being used to passively configure emulated routers and hosts according to the specification scheduled" [6].

VIII. Resolution Method

Inside the GNS3 simulation environs, it's conceivable to take advantage of the complete practical Different real adapters by mixing of OS images Cisco or Juniper manufacturers. These species will exist together in a Topology that matches the reality of a specific network as feasible. Throughout Figure 3, there is an important example of topology that was obtained with the use of the GNS3 simulation setting for the research resolutions. In the context of this shorter topology, a data center for public bodies, a data canter for universities, a service provider, and many other cloud service companies, the Wire Shark Network Interface Analysis Tool for fault/error/failure/alarm test. Would be actual time overwhelming and unwieldy. Conversely, GNS3 doesn't propose the other essential likelihood for disaster examination regarding traffic movements and routing performances. A rise within the complication of so, topologies will increase the fault/error/failure/alarm test trouble and time mandatory. GNS3 provides a free network traffic capture programming interface for further evaluation in the sense of a virtual network system between competing routers and our virtual appliances.

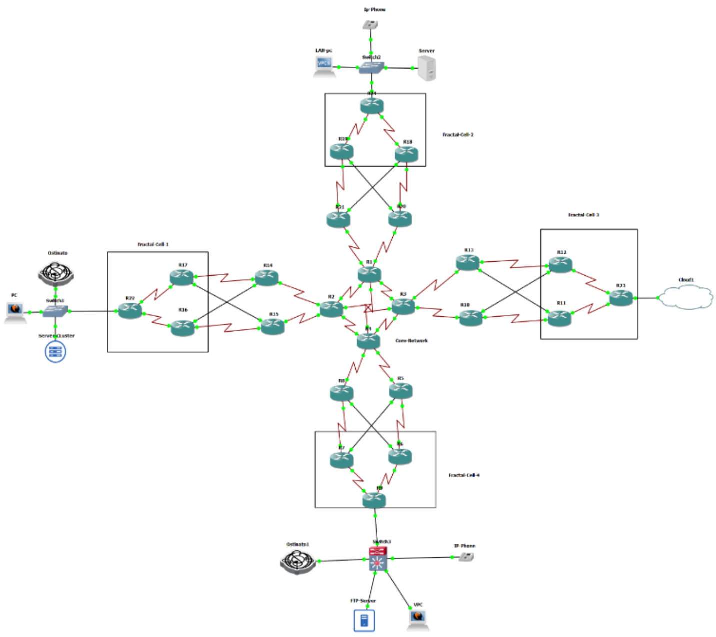

Figure 4. Experimental and Topological Design of FAST-BAM.

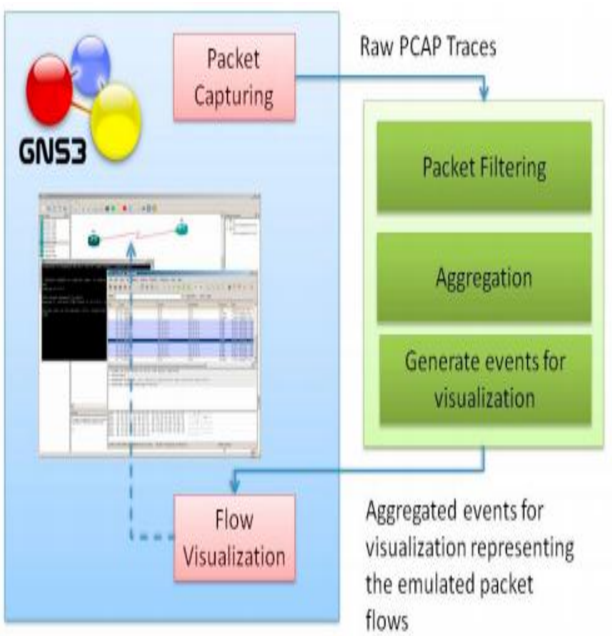

Figure 5. Visualization of Packet Capturing and Analysis in GNS3.

Hypothetically, the projected architecture also can be utilized in true network environs, meanwhile, The interface that is used for monitoring network traffic upstream and downstream is still used obtainable on outdate network operating systems (NOS).

Alternative methods are often erased by advancing a software component for examination, sorting, and transferring of stored network packets of unexpected programming libraries. If this data is generated in a network simulation environment or disrupted from a true network, the data is collected (IP packets registered) during the same PCAP setup. For the distribution of these data, archives are available for various program design languages that shorten Network traffic data transfer software

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modules. The component's implementation expansion program should be tracked. The module-based techniques, adapted to the kind of data obtainable or the simulation world, allow the flexibility of adapting different aspects automatically from the general design and of adapting the general system to the changed circumstances of the schedule solutions.

IX. Implementation

Assessment topology approaching a disappointment situation was created for the ultimate exploration of the execution (Figure 6). The influences among different entire network- The optics of the packet tracks in the virtual topology are shown in red-defining. The network relation (Figure 6) is shown as a let-down network link. The information packets are transmitted via a replacement network (R2) interface that can also be visually highlighted using brown-exposed data pathways. The automated trying to redirect occurs in the complicated emulated nodes of the simulated network with the configured OSPFv3 spirits.

The development demonstrates the operation of the conception resolution mechanism and may be cast-off. The operating capacities were administered during the test runs with testing equipment, which was used to function both in the ostinato and simulation areas of GNS3 and hence the design structures created. Efficient data processing, continuous recovery inside the DS of unauthorized data packets, and robust implementation of GNS3 simulation traffic stream consumers have been carried out to establish the functional limits of the general architecture.

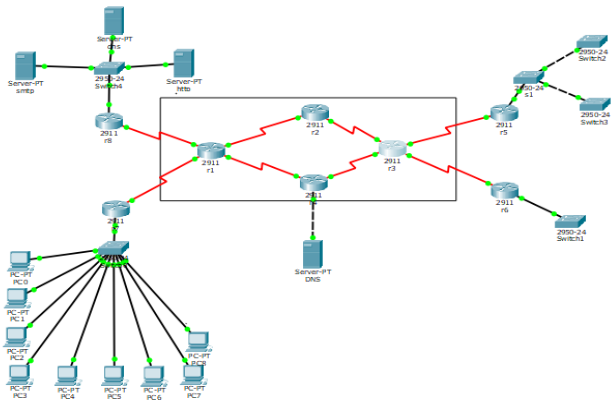

Figure 6. Test FAST-BAM model Topology Connection.

X. System Requirement

A virtual hardware system with consequent criteria has been used to evaluate a deployed and evaluate ecosystem for the implementation of the pronounced device for GNS3:

A modified GVM computer for the network environment (CPU: 8 sockets with 4 cores per sockage, 24 GB of RAM, 4 Network Interface Cards) and the backend modified system with (CPU: 8 sockets with 8 core per Socket, 32 GB of RAM) GNS ostinato server (Intel Hyper-V support, AMD ® Radon 9410 ® (16x) CPU RYZEN @ 3.55Ghz, 32 GB of RAM).

XI. Outcome, Comparison, and Matrices

The things utilized in the research are the Cisco 7000, 2600, 3500, and Cisco 7200 IOS routers. The FAST-BAM model is situated on a central regulator, linked to routers over a 1 GBPS CAT-6 568-a and 568-b UTP link. The server comprises a video frame system of 1080 pixels' resolution with identical packet size. This video is going to be transmitted to the consumers to live the excellence of the video within FAST-BAM models. The investigational data revealed in below tables contain the subsequent metrics:

• VoIP latency: Interruption between the processing and delivery of a packet.
• VoIP jitter: The time of the following two packets transferred.
• Response period for the page: initial session pause and thus full web site delivery.
• Round-Trip Time (RTT): the delay since the ICMP packet was submitted to the receiver ACK.

The standards are characterized by milliseconds (ms). The estimation process includes stimulating IP SLA router inquiries and complete interlocking contact programming. The findings were replicated 10 times while an equivalent case was reproduced to maintain the validity of the data collected.

Table 1. HTTP Response Page (ms)

Packets size (Bytes)	FAST-BAM	SAM	RDM	MAM
256	612	620	620	344
367	615	620	620	400
512	634	650	650	556
768	656	684	684	668
1024	742	750	770	770

Table 2. ICMP RTT Page (ms)

Packets size (Bytes)	FAST-BAM	SAM	RDM	MAM
256	52	60	64	60
367	76	90	100	120
512	116	130	140	150
768	128	148	180	176
1024	138	190	220	200

The variables used in the experiment are: the G.711 allows VoIP codec, HTTP version 1.1, and the Don't Fragment (DF) flag set to be used with ICMP Echo type.

Table 3. VoIP Jitter (ms)

Packets size (Bytes)	FAST-BAM	SAM	RDM	MAM
256	8	11	19	19
367	10	14	36	40
512	13	17	60	64
768	15	18	65	136
1024	33	50	80	148

We can't think about the video output across the QoS. Figure 7 displays a video series intercepted with the smart distribution, RDM, and MAM versions with Peak Noise Ratio(PSNR). The MSU Video Performance Measurement System offers these requirements. The assessment technique is focused upon a high-resolution file saved on the server evaluating the content of the video captured by a recipient. The ensuing CSV document includes numerical values produced in this graph.

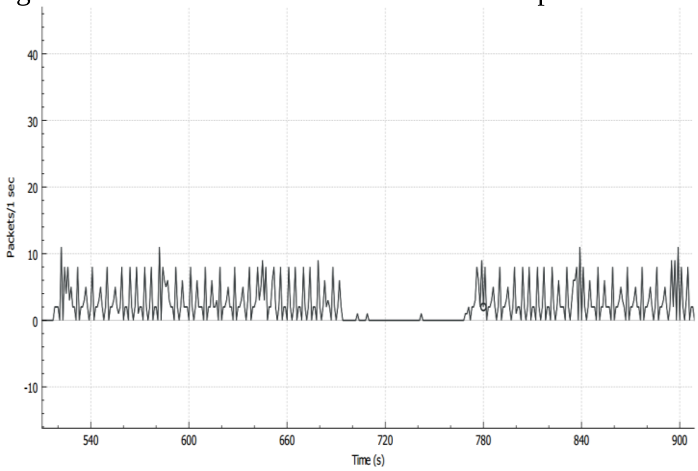

Fig. 7: 64 Packets Transmission of (PSNR)

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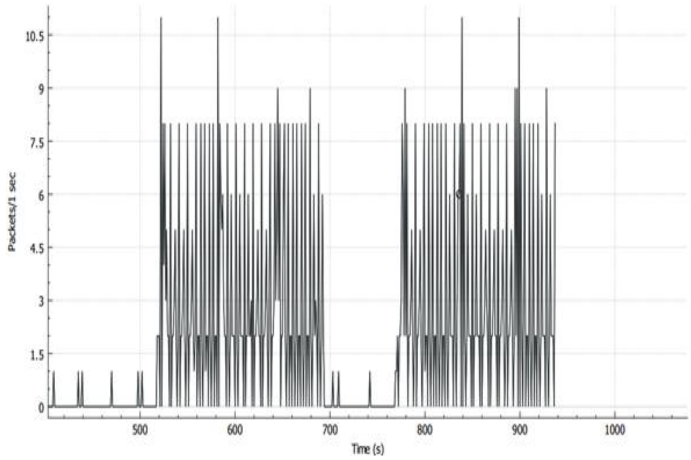

Fig. 8: 128 Packets transmission of (VoIP)

XII. Conclusion

In this paper, we introduce a fractal-cell smart topology bandwidth allocation model into network reliability and efficiency analysis of the Next Generation Network and propose a topology and efficiency based network allocation model. Via means of fractal cell concept and protocol matric applied in FAST-BAM, we classify the fractal-cell in network topology as link switching between two core router and network layer routing protocols and binding it up with new fractal-cell topology at the serial node of a router which composed with topology, routing protocols and the serial ports. This topology was suitable for the large scale bandwidth networks which provide higher data rate traffic solutions over the multilayer routing devices.

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