# Congestion Control in Distributed Networking System-A Review

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## ABSTRACT
With the rise of user based on distributed network system, traffic congestion is one of the unavoidable situations. Distributed network consists of various networks, processors and intermediary devices that overload the switches or routers with high traffic and it is because of the design fault in the distributed networking architecture. Even though several researchers address the congestion detection technique, its avoidance and mitigation in their research are hard to be explored for any effective solution for this problem. This paper investigates the work being carried out in the recent past for finding an effective solution to this serious problem. In addition to that the study also proposes an idea of cross layer technique that can be adopted to have an effective control on congestion in distributed networks.

## Keywords
Cross layer, Congestion Control, Distributed Network, Layered Approach, Quality of Service.

## 1. INTRODUCTION
Congestion can be outlined as a state or condition that happens once the network resources are over burdened resulting in faulty issues for network users as objectively measured by the likelihood of loss or delay. The overload also leads to the minimization of usefulness in any networks that support each spatial and temporal multiplexing but with no reservation [1]. Congestion management could be reflected as (typically distributed) algorithm to share network resources among competitory traffic sources. Two elements of distributed congestion management are outlined within the context of primal-dual modeling [2]. Primal congestion management refers to the algorithmic rule executed by the traffic sources for dominant their causing rates or window sizes. This is often usually a closed-loop management, wherever this procedure is highly dependent on feedback. TCP protocol basically comes under this class. Dual congestion management is functioned by the routers through gathering data regarding the traffic traversing them. A twin congestion management algorithm updates, implicitly or expressly, a congestion quantification or congestion rate and sends it back, implicitly or expressly, to the traffic sources that use that link. Queue management algorithms like Random Early Detection (RED) [3] or Random Exponential Marking (REM) [4] make up the "dual" class. Congestion management provides for an elementary set of mechanisms for maintaining the steadiness and potency of the internet.

In order to achieve high end-to-end throughput and efficient resource utilization, congestion control, routing and scheduling should be jointly designed while the architectural separation among them is preserved. Congestion control is a fundamental mechanism for the stability of the distributed networks and is a central mechanism of TCP. However, TCP congestion control algorithms can be interpreted as distributed primal-dual algorithms over the Internet to maximize aggregate utility. Hence, there is a need of studies that excavates the loopholes in various approaches and assists to identify a design of new congestion control technique. In the proposed review paper, we conduct an in-depth study about congestion, its source of occurrence, various techniques adopted in past research work to address these issues and conclude with a discussion on some open research issues that requires a serious attention. In section 2 we give an overview of congestion control in DNS followed by section 3 that discusses on existing models on congestion controls. Various open research issues are discussed in Section 4. Section 5 discusses about evolving and futuristic internet technologies. A brief description of fundamental of future internet technologies is jotted in Section 6 followed by concluding remarks in Section 7.

## 2. CONGESTION CONTROL IN DNS
The key components of Distributed network architecture are, as the name implies, the distribution of decision-making and management out to network site, whereas at the same time, networking and synchronizing the assorted sites along via a central hub. It is to be noted that distributed network system must not be thought of as associate uniting of electronic network such as the internet. Hence, we are going to discuss the particular distributed network system that may be additionally classified into a very large network of internet, wireless sensor network, and mobile adhoc network. This section will present a number of the most important contribution of congestion management techniques in distributed network system.

Congestion management in network: Congestion management mechanisms in today's Internet (See Fig.1) already represent one amongst the biggest deployed artificial feedback systems, because the internet continues to expand in size, diversity, and reach, taking part in an ever-increasing role within the integration of different networks (transportation, finance, etc.). Therefore, to retain a solid understanding of however this basic resource is controlled becomes ever more crucial. This section discusses concerning all the most important work dispensed to address congestion controls in networking.

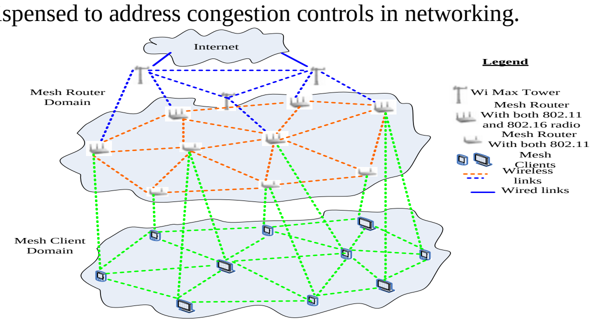


**Figure 1 Modern Internet architecture**

Seferoglu et al. [5] have conferred findings on TCP-induced packet losses of TFRC (TCP Friendly Rate Control) flows and their relation with the delay samples and their derivatives as collected/computed at TFRC senders and receivers. Mao et al. [6] have developed a hybrid traffics Active Queue Management (AQM) router with classifier and scheduler that make sure the link capacities of each traffic. The author has conferred some easily verified adequate stability conditions for the AQM policy to stabilize the TCP and UDP queues in routers. Shiang and Schaar [7] have proposed a content-aware congestion management for multimedia system streaming over TCP/IP networks achieving higher than 3dB improvement in terms of PSNR over the traditional TCP congestion control approaches, with the biggest enhancements discovered for real-time streaming applications requiring rigorous playback delays. Rahman et al. [8] have introduced a proxy transport layer protocol Datagram Congestion Control Protocol (DCCP) that's appropriate for these applications due to its exclusive characteristics. Zhou et al. [9] have presented a congestion window adaptation formula for the MPTCP (Multipath Transport Control Protocol) supply that dynamically adjusts the congestion window for every TCP sub-flow therefore on mitigating the variety of end-to-end path delay. It addresses both wired and wireless networks.

Congestion Control in Wireless Sensor Network: A Wireless sensor Network (WSN) contains the highest number of sensor nodes. All of the scattered wireless sensor nodes have the potential to gather and route information either to alternative sensors or back to an external base station that will be static or mobile. Networking unattended sensor nodes could have a profound result of the performance of many military and civil applications like target field imaging, intrusion detection, weather observance, security and strategical investigation, distributed computing, detecting ambient conditions like temperature, movement, sound, light, or the presence of certain objects, inventory control, and disaster management. Figure 2 shows the schematic diagram of sensor nodes elements.

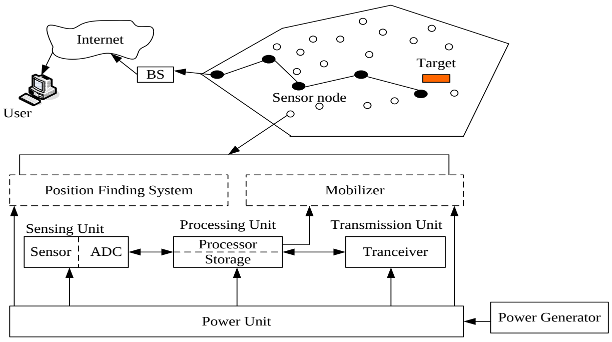


**Figure 2 Schematic diagrams of sensor node components**

This section discusses about all the major work carried out to address congestion controls in wireless sensor network.

Chandure and Gulhane [10] have conferred techniques congestion management that minimizes congestion within the network and varied suggestion for congestion management in wireless sensor network. Waghole and Deshpande [11] have additionally targeted on congestion issue by reducing average End-to-End Delay by deploying Movable Mobile Sink in uniform Random Wireless Sensor Network. Yedavalli [12] has analyzed the queue dynamics within the wireless sensor network using fluid models and exponential back-off based mostly service rate models and shows that they match the simulation results closely and conferred a symptom of construct that advantage of wireless surroundings is used for congestion management in wireless sensor networks in line with their results accomplished. Reddy [13] have designed protocol for a queuing model for generating the heterogeneous traffic among every sensor node in line with the priority such that by the sink. Baskarane and Akila [14] have represented varied kinds of sophisticated assaults initiated from antagonist with internal access to the WN. Priya and Terence [15] have projected a protocol specifically EECP (Energy efficient and Congestion-aware Protocol) that helps to realize correct event detection, energy potency and fewer traffic offer a helpful MA (Mobile Agent)-based clustering algorithm (MACA) to realize each energy potency and congestion resolution. Gupta et al [16] have projected a protocol that deals with the minimum energy consumption and congestion less transmission between the multi-hop clustering in wireless sensor network. The projected protocol minimizes the congestion at the bottom station and improved throughput by using round Robin programming at inter-cluster communication. The projected approach is additional scalable than the prior resolution. Chakravarthi and Gomathy [17] projected a cost effective protocol in wireless sensor network to discover and manage congestion MAC.

Congestion management in Mobile Adhoc Network: A Mobile Ad-hoc Network (MANET) is a kind of sort of wireless network that generally includes mobile routers and in some cases additionally portable devices with minicomputers. The schematic diagram of MANET system is as shown in Fig.3. These wireless mobile nodes are connected by wireless links to make a varied discretional network topology. This section discusses regarding all the main work carried out to deal with congestion controls in mobile adhoc network.

Bullibabu and Ramesh [18] have conferred a multi-rate multicast congestion management policy appropriate for mobile ad-hoc networks. The projected theme overcomes the disadvantages of existing schemes that resist them from being applied to MANET situations (e.g., being affected adversely by link access delays caused by access competition and by high link error rates; having excessive management traffic overhead). Rathod and Patel [19] projected a network cryptography and congestion aware routing mechanism approach in MANET providing elaborated analysis of an existing coding and congestion aware routing protocol.

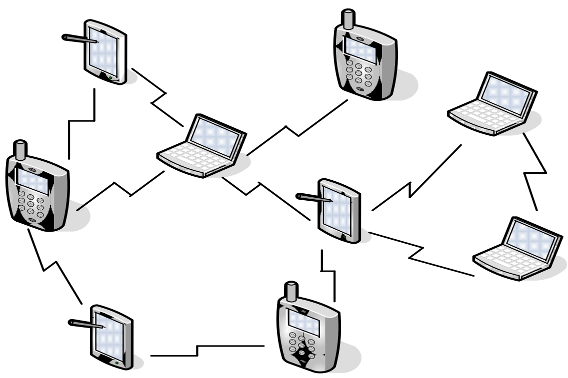

**Figure 3 Schematic diagram of MANET system**

Sheeja and Pujeri [20] proposed to develop a scheme called as an Effective Congestion avoidance scheme that consists of congestion observation, effective routing establishment and congestion-less based routing. Bawa and Banerjee [21] propose a load equalization approach in AOMDV (Adhoc On-Demand Multipath Distance Vector Routing) protocol that uses queues that are used for congestion monitoring. Reddy [22] has introduced a new cross layer and path restoration procedure in painter that derives 2 algorithms for Path discovery and congestion management correspondingly. Rajeswari and Venkataramani [23] assess the performance of four queuing disciplines (FIFO, PQ, RED and WFQ) that is enforced within the adaptive Energy efficient and a Reliable Gossip Routing (AEERG) protocol in Manet. Rao et al. [24] have planned an energy efficient and reliable congestion management protocol for multicasting in mobile ad-hoc networks (MANETs). Srinivas and Chari [25] have planned MAC layer level congestion detection mechanism to deliver an energy economical mechanism to quantify the degree of congestion at victim node with peak accuracy. Rao and Shrivastava [26] have mentioned a framework for managing congestion by applying efficient native route repair technique in AODV protocol in MANET. Choudhary and Singhal [27] have planned a completely unique approach of congestion management for supporting applications like transmission streaming over MANET. Ahirwal et al. [28] have given technique for avoiding congestion in MANET surroundings using the channel capacity estimation technique.

## 3. EXISTING MODELS ON CONGESTION CONTROL

This section discusses concerning model that are often represented for managing (controlling) congestion in distributed networks. Two models for congestion management specifically layered design and the cross-layer design of distributed networks are mentioned.

### *a) Models supported layered Techniques:*

Network architecture determines functionality allocation instead of simply resource allocation. The layered architecture (See Fig.4) is one of the most fundamental structures of network design.

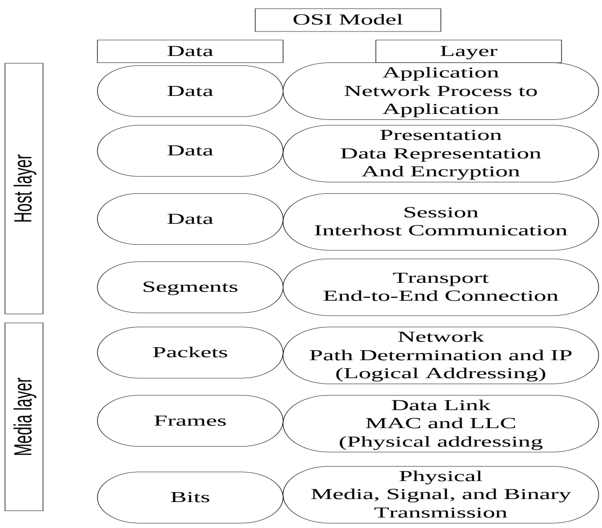


**Figure 4 Layered approach**

They adopt a modularized and sometimes distributed approach to network coordination. Every module, specific layer, controls a set of the decision variables, and observes a set of constant parameters and therefore the variables from alternative layers. Every layer within the protocol stack hides the complexes of the layer below and provides a service to the layer on top of. Intuitively, superimposed layered-based architectures enable a scalable, evolvable, and implementable network style, whereas introducing limitations to efficiency, fairness and potential risks manage the network. The traditional layered protocols in distributed networks tend to suffer from the inability to segregate between losses owing to route failures and congestion attributable to the inflexible structure. In order to beat the challenges of the dynamic environment, protocols those deem interactions between different layers are considered as an important factor. Generally it's necessary to possess info from numerous layers so as to create a call in higher layers of the network. This might end in better decision making once it involves routing, allocating resources, controlling congestion and scheduling [29].

### *b) Models based on Cross-Layer Technique:*

Cross-layer design is turning into more and more vital for enhancing the performance of multihop wireless networks. By at the same time optimizing the management across multiple protocol layers (See Fig.5), cross-layer design will considerably increase the network capability, scale back interference and power consumption. The cross layer design is a promising technique for performance improvement in distributed networks. Cross layering permits network layer that commonly are unable to communicate within the conventional layered network models to share information [30]. The shared information could enable a lot of intelligent higher cognitive process in terms of congestion management. Cross layer approach to congestion management don't need precise prior data of the capacity of each link. In this approach to congestion management the network collectively optimizes both the information and also the resource allocation at the underlying layers [31].

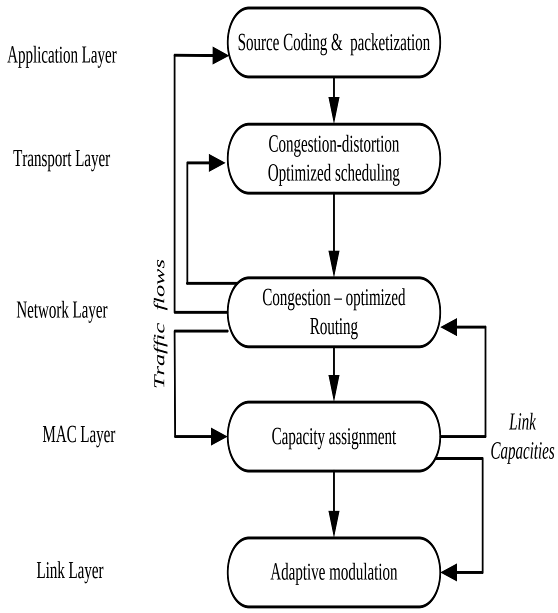


**Figure 5 Cross Layer Approach**

The performance of communications protocol and MAC layer protocols of the layered design is often evaluated using metrics like output, bandwidth delay product, Packet delivery ratio, and delay and Packet loss. On the other hand, the cross-layer approach to congestion management will apportion information rates while not requiring precise previous data of the capacity region. Here, by the "cross-layer" approach to congestion management, we mean that the network conjointly optimizes each the information rates of the users and therefore the resource allocation at the underlying layers that embrace modulation, coding, power assignment and link schedules, etc. [32]. The discussion proves that the cross layered design is more practical in controlling congestion and supply higher QoS than the layered approach. The prime objective is to formulate the mathematical framework related to a stochastic analysis to regulate Congestion in networks since the network exhibit randomness in its behavior. So cross layer design with a random model encouraged to be the most effective technique to regulate congestion in distributed networks.

### c) Models based on Deterministic Technique:

Deterministic model accommodates outcomes that are exactly determined through best-known relationships among states and events, without any room for random variation. In such models, a given input can continually turn out an equivalent output, whereas deterministic models are shown to very accurately predict the common rate of flow such models cannot capture the variance within the rate method which can arise because of totally different sources of randomness. In real systems, there are two key sources of randomness. First, there are often unresponsive flows that don't react to congestion management. For example, these might be traffic generated by UDP flows within the network. Such unresponsive flows are often designed as stochastic disturbances instead of the deterministic model within the router. Second, the marking selections at the router are probabilistic that once more match with the random nature [33].

### d) Models based on Stochastic Techniques:

Stochastic Model is dedicated to the idea and applications of likelihood as they arise within the modeling of phenomena within the natural sciences and technology. It presents contributions on the mathematical methodology, from structural, analytical, and algorithmic to experimental approaches. Senbagam [34] have planned a congestion management model of a network of signalized intersections supported a discrete-time, steady state Markov decision method. Xian and Levinson [35] have proposed a random congestion and rating model that mixes a bottleneck model with random queuing to review route congestion and routing. Random Petri nets (SPN) [36] are accustomed to study the interaction of multiple TCP sources that share a standard buffer. Tokens related to SPN represent the buffer occupancy and the congestion window size. The continuous-time Markov chain model with SPN provides realistic modeling of work and system modeling to regulate congestion.

## 4. OPEN ISSUES IN DNS CONGESTION CONTROL

### Challenge 1: Network Support

Network elements may be concerned in congestion management in two ways: First, they will implicitly optimize their functions, like queue management and provisioning methods, so as to sustain various operations of end-to-end congestion management. Second, network elements will participate in congestion management via specific communication mechanisms. Even supposing these implicit techniques are renowned to enhance network performance throughout congestion phases, they're still solely part deployed within the networking. This could result to the actual fact that finding the best and sturdy parameterizations for these mechanisms could be a non-trivial drawback. Several Accommodative Virtual Queue schemes (REM, RED, PI-Controller, and BLUE, however conjointly Accommodative Virtual Queue) [37] don't outline a scientific rule for setting their parameters. Congestion is an inherent network development and might solely be resolved expeditiously by some cooperation of end-systems and therefore the network. Congestion management in today's web protocols supports the end-to-end design principle insofar as solely least feedback from the network is employed, e.g., Packet loss and delay.

### Challenge 2: Corruption Loss

It is common for congestion management mechanisms to interpret the packet loss as an indication of congestion. This can be accepted once the packets are declined in routers owing to a queue that overflows however there are different doable reasons for packet drops. Transmission control protocol over wireless and satellite may be a topic that has been investigated for an extended time [38]. The concept of getting a transport end detection and consequently reacting (or not) to corruption poses a variety of fascinating queries relating to cross-layer interactions. As the Internet Protocol (IP) is meant to work over data link layers, it's thus tough to design a congestion management mechanism on prime of it that fittingly reacts to corruption -- particularly because the specific physical layers that are in use on an end-to-end path are generally unknown to entities at the transport layer. Whereas the IETF has not yet specified however a congestion management mechanism ought to react to corruption, proposals exist within the literature, e.g., [39].

### Challenge 3: Packet Size

TCP doesn't take packet size under consideration once responding to losses or Explicit Congestion Notification (ECN). The renowned square root formula furnishes an estimation of the performance of the communications protocol congestion avoidance protocol for communications protocol Reno [40] there is a substantial body of analysis on the way to distinguish whether or not packet drops are attributable to transmission corruption or to congestion. However the total list of equivalent causes of loss is longer and includes transmission corruption loss, congestion loss (bit congestion and packet congestion), and policing loss. The open issue here is whether or not a loss or express congestion mark ought to be understood as one congestion event no matter the dimensions of the packet lost or marked, or whether or not the strength of the congestion notification is weighted by the dimensions of the packet. This issue is mentioned at length in [40], beside other aspects of packet size and congestion management.

### Challenge 4: Flow Startup

The beginning of information transmissions imposes more distinctive challenges: once a connection to a new destination is established, the end-systems have hardly any data regarding the characteristics of the trail in between and therefore the offered channel capacity. During this flow startup scenario, there is no obvious selection in a way to begin to send. An identical drawback additionally happens when comparatively long idle times, since the congestion management state then now not reflects current information regarding the state of the network (flow restart problem). Van Jacobson [41] recommended deploying the slow-start mechanism each of the flow startup and therefore the flow restarts, and this can be today's normal answer [42]. Finally, the slow-start doesn't make sure that new flows converge quickly to an affordable share of resources, notably once the new flows compete with durable flows and are available out of slow-start early (slow-start vs. overshoot tradeoff). This convergence drawback could even worsen if additional aggressive congestion management variants are wider used.

### *Challenge 5: Multi-Domain Congestion Control*

Transport protocols like protocol operate over the web that is split into autonomous systems. These systems are characterized by their non-uniformity as Internet Protocol (IP) networks are accomplished by a large number of technologies. ECN [43] is an example of a congestion feedback mechanism from the network towards hosts. However, it provides rise to non-compliance attack and subversion attack permit an offensive network to cause excess congestion in an upstream network, although the transports were behaving properly. Another contradictory answer in very multi-domain surroundings is also the TCP rate controller (TRC), a traffic conditioner that regulates the protocol flow at the ingress node in every domain by dominant packet drops and delays of the packets in a very flow. The outgoing traffic from a TRC-controlled domain is formed in some such way that no packets are born at the traffic policer. However, the TRC interferes with the end-to- end protocol model, and therefore it might interfere with past and future diversity of protocol implementations (violating the end-to-end principle). The futuristic evolution of web inter-domain operation needs to show whether or not a lot of multi-domain data exchange is effectively completed. From this angle, security problems ensuing from restricted trust between totally different management units end in policy enforcement that exacerbates the issue encountered when explicit feedback congestion control data is changed between domains.

### *Challenge 6: Priority for Flexible Traffic*

Traffic initiated by common elastic applications (HTTP and instant-messaging traffic) adapts to the available channel capacity deploying feedback concerning the state of the network. In brief, elastic information applications will show highly completely different needs and traffic characteristics. There is a problem over a way to reconcile two divergent views of the relation between traffic category precedence and congestion management. However, it's an open issue however the two approaches may co-exist or however one may evolve into the opposite.

### *Challenge 7: Misbehaving Senders and Receivers*

The presence of the enormous variety of users on the web uses numerous application that implicitly posses harmful intentions. Therefore, the presence of such misbehaved users imposes an excellent deal of threat in network traffic congestion. A growing proportion of network traffic comes from applications designed to not use congestion management in the least, or worse, applications that add a lot of forward error correction as they witness a lot of losses.

## 5. VISUALIZING FUTURISTIC INTERNET TECHNOLOGIES

For the past ten years, the network specialists have realized the boundaries of the web and have caused a series of analysis works to enhance and complement the issues origination from this web. But, these progressive evolutionary approaches to satisfy the new needs are merely ad-hoc techniques to not cause the affordable and complete solutions. In alternative words, their researches are solely unsophisticated improved to safeguard the IP-based design. In fact, the improved technologies in the present could worsen the things in spite of possible launchings. NGN (Next Generation Network) from ITU-T, IPv6 (IP version 6), Mobile IP [44] and IP Security occupy levels of the temporary improvement. Ironically, the skepticism to not overcome the constraints occurring in today’s web by the evolutionary approach raised from the highest engineers architect the initial internet. They claimed that a replacement trial to not be dependent upon the present technologies and solutions ought to break through this perplexity. Their plan may be a revolutionary style of the long run network by the clean-slate approach. The clean-slate design means that to create a future network from the blank by denying this web. Future web is rising with this yearning to a brand new network to supply revolutionary services, capabilities and facilities that are exhausting to produce using existing network technologies

## 6. TECHNOLOGIES OF FUTURE INTERNET

The analysis on the technologies of the futuristic internet remains at a preliminary stage to refine the necessities related to the defined goal since started from the US in 2005 [45]. The main analysis areas round the common and basic technologies of the longer term networking fall under 3 categories; service, design and infrastructure. The futuristic services and applications target the provisioning of the specified service at the time and therefore the price users want. Users of the longer term would require the top quality service to replicate the ideas of ‘I-centric’, ‘situation-awareness’. They need the proactive service giving consistent with their requirements and preference and therefore the seamless service to ensure service accessibility underneath any circumstance. Thus, the service of the futuristic networking involves technologies related to data-centric or contents-centric services and context-aware services. The internet of things, virtual reality, web2, augmented reality interfaces and media distribution are the objectives of future services. Currently, Planet Lab, VINI and GENI [45] are used as major infrastructures to experiment new protocols and applications. GENI is that the large-scaled test-bed to produce ability with world globes. Figure 6 shows the basic technologies to belong to the analysis paradigms of the futuristic networking. The analysis comes from the futuristic networking and is being enlarged most activities within the US who was a number one country to dominate the spread of the present internet. NSF initiated a following project known as FIA (Future internet Architecture) in 2010 [45]. FIA consists of four subprojects; NDN, Mobility First, NEBULA and XIA [45]. NDN (Named information Networking) is getting into the look of contents-centric specification. Mobility First is inquisitive about the support of user’s quality so as to make sure the context-aware or the location-aware service.

NEBULA [45] can be stated as a prototype tool to work on a cloud design related to the data centers with high reliability and speed. XIA (eXpressive internet Architecture) puts its primary objective on the protection issue. It suggests the network architecture to guarantee secure transmission among communication entities of host, service and contents etc. In parallel with the analysis of the design, NSF raised a project of GENI (Global environment for Network Innovation) because the international test-bed to verify the technologies for the long run web in 2005. Numerous paradigm researches are experimented on GENI since 2008. GENI’s ultimate goal is to supply an oversized scaled infrastructure for new technologies to not be effectively tested over the present web. GENI is predicated on the productive operation of former experimental networks; Planet LAB and VINI (Virtual Network Infrastructure) [45]. Currently, outstanding technologies and concepts as well as network Virtualization and programmable network are being much developed underneath GENI management framework. Europe has been driving the analysis projects of next-generation network by EURO-NGI/FGI beneath FP6 (Framework Program 6) [45] that may be a joint analysis program by EU countries since 2006. Currently, specific operating teams square measure leading the analysis subjects from the areas of design, wireless, service, test-bed and security. Essential technologies relating to network Virtualization and programmable platform are underneath the event. FN2020 Forum sponsored and shaped by the government in 2010 is progressing to designing the strategy and vision to include the development of sensible network revolving the long run network.

# 7. CONCLUSION

The demand for the present day scenario is the congestion free and high performance network. But while dealing with massively distributed networks to achieve high performance with present day layered approach in controlling congestion is found to be a difficult task. In this work it is found that the research in the past several years in controlling the congestion does not provide effective solutions. Hence we would like to propose the cross layer architecture for better congestion control and cost effective communication.

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