INTERNATIONAL JOURNAL OF SCIENTIFIC RESEARCH IN ENGINEERING AND MANAGEMENT (IJSREM)
VOLUME: 03 ISSUE: 06 | JUNE -2019 ISSN: 2590-1892

Efficient caching approach in Content Centric Networking using Proxy Server and Gateway Router

Rashmi R,Mtech Student
Dept of Information Science & Engineering
BMS college of Engineering
Bangalore,India
rashmir.scn17@bmsce.ac.in

Dr M Dakshayini,Professor
Dept of Information Science & Engineering
BMS college of Engineering
Bangalore,India
dakshayini.ise@bmsce.ac.in

Abstract— Internet Architecture is moving from host centric paradigm towards content centric network paradigm in order to address challenges faced by TCP/IP architecture. Usage of Internet is so frequent in recent days that host centric paradigm doesn't match with increasing demand of data traffic. Content Centric networking (CCN) is an advanced architecture that address the challenges faced by TCP/IP architecture using caching methodology Caching is an important concept in CCN that handles delivery of repeated content and it avoids contacting the server multiple times for serving the repeated request. We have proposed a new innovative approach for serving multimedia content in Content Centric networking using Proxy Server and Gateway Router (PSGR) concept. This architecture is capable of handling the repeated request in an efficient manner and properly utilizing network bandwidth. We evaluate our approach using a small network topology with cache hit as the main factors that helps in improving the performances. Results show that when data is cached, performance increases and reduction in user response time.

Keywords— Information centric networking (ICN), Content Centric networking (CCN), Proxy Server (PS), gateway router, Information centric network (ICN), Interest packet, content packets.

I. INTRODUCTION

TCP/IP is a host centric architecture which is 45 years ancient and in the late 1960s was originally identified for sending electronic email from one computer to another. Host centric architecture is facing lot of issues in today's world to satisfy the consumers demands. Issues are limited number of hosts available to serve request, shared network resources among all the nodes. Nowadays, people spend more time in streaming Netflix movies, a piece of content must be distributed to hundreds of thousands or millions of users promptly and in real time. With this growth and shifts in usage, the Internet is being severely hassled. Frequently trapped in watching a "buffering" note when we are trying to watch a viral video. Internet users of today are demanding faster, more efficient and additional secure access to content without being concerned location of contents [1][2]. We need Internet which can provide quick response with less utilization of bandwidth to users at a single stretch securely, this can be done using Content centric network (CCN).

TCP/IP architecture served the purpose of resource sharing by using connection-oriented model with client-server communication and IP address concept. With growth in technology resource sharing problem is out of focus and nowadays Internet is motivated with content dissemination with evolution of content centric networking (CCN). Every node in CCN can serve client request foreach Interest packet, looking for content packet in all nodes present in network. Every node in CCN uses caching strategy to store contents [3].

CCN is an important concept of Information centric networking (ICN) to support massive growth of information in Internet. ICN concepts are known under different terms shown in figure 1. Palo Alto Research Centre (PARC), in California came up with CCN initially and this approach fundamentally changes the way information is organized and retrieved and improves network reliability, scalability, and security[4].

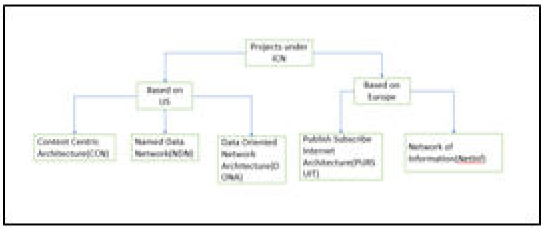

Figure 1: Hierarchy of ICN

Content Centric network had different release on how a content packet is fetched based on Interest packet. Here are the different releases of CCN.

- CCNx 0.x – here CCN node always returns the possible prefix match. For example, interest packet looks for /a/b, CCN node can return content packet of /a/b/c/d or /a/b.
- CCN 1.x – Content packets are returned based on the exact match of Interest packet. For example, interest packet looks for /a/b, CCN node would return content packet /a/b only.

In CCN, when we navigate to a website or click on a link, it automatically generates hundreds of interest packets to looking for content packet to make up page. An interest packet is travels each of the CCN node looking for content packet if the node doesn't have the content then node would forward it to CCN forwarder. Many companies together with Alcatel-Lucent, Huawei, Intel, Panasonic, and Samsung had substantial R&D efforts focused more aspects of CCN in recent years [2].

To overcome all the drawback of traditional internet architecture and to properly utilize the bandwidth and reduce the response time in delivering content packet to user and by increasing the cache hit rate, we have proposed a new approach for CCN. This technique focuses on contents that are cached at Proxy Server and gateway router. With this caching techniques the overall performance of CCN increases.

This paper is structured in following manner: summary of literature survey is present in section II. PSGR architecture is covered in section III. Data structure used in this architecture, interest packet forwarding mechanism with an example is explained in section IV. Caching mechanism is covered in section V. Simulation results are covered in section VI. Conclusion is covered in section VII.

II. LITERATURE SURVEY

Content Centric Networking Wikipedia details about the different releases in CCN, motivation and benefits towards it [1]. IEEE Spectrum explains about TCP/IP internet and in today's Internet using CCN [2]. Gyan Prakash Mishra and Mayank Dave highlighted about key concepts of CCN and its core functionalities. They even proposed caching algorithms [3]. Muhammad Azfar Yaqub, Syed Hassan Ahmed, Safdar Hussain Bouk and Dongkyun Kim authors have explained different projects involved in the ICN architecture and basic flow of interest and data packet in all the projects [4]. Gyan Prakash Mishra and Mayank Dave explained cost effective caching that helps to cache contents without replacements [5].

III. PSGR ARCHITECTURE

PSGR network architecture is a two-tier architecture. The network consists of isolated local proxy server group (LPSG), each LPSG contains a set of peer nodes. These nodes are connected to a local proxy server are considered as part of tier-1. All tier-1 networks are interconnected and can communicates with each other. They also connect to gateway routers (GR) and are considered as part of tier-2. All tier-2 nodes communicate with each other and are connected to central server directly. This way of organizing helps in handling the multiple request in a quick manner. Advantages of this approach is with increasing caching space at proxy server and gateway router increases the cache hit rate and reduces the waiting time of user with lesser amount utilization of bandwidth. This approach is more efficient when compared to other architecture in CCN. Figure 2 shows a small network with 2 LPSG and a GR in PSGR architecture.

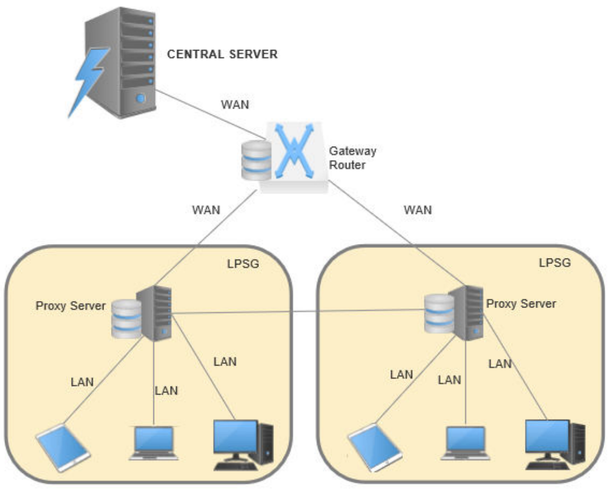

Figure 2: PSGR architecture

IV. DATASTRUCTURES USED IN PSGR

Each node maintains three different data structures for retrieving the content packet for requested interest packet. Following are the data structures used.

- Content Store (CS) - CS is a buffer storage used to cache the propagating content shown in table 1
- Pending Interest Table (PIT)- PIT is a table which lists requested interest packet, requesting nodes and port number shown in table 2.
- Forwarding Information Base (FIB)- FIB contains list of ultimate sources of content shown in table 3.
- Index Table at GR- This table maintains all the LPSG multimedia content details.

Table 1: Content Store

Name	Data
/multimedia content/t1	Content1
…	

Table 2: Pending Interest Table

Prefix	Requesting nodes	Requesting port number
/multimedia content /t1	PS/GR	8801
…		

Table 3: Forwarding Information Base

Prefix	node list	Gateway
/multimedia content/t1	PS	GR
…		

Table 4: Index table in GR

Prefix	node list	Gateway
/multimedia content /t1	PS^1	GR1
…	..	
/multimedia content /t^n	PS^n	
/multimedia content /p1	PS^1	GR^n
…	..	
/multimedia content /p^n	PS^n	

A. *Interest packet forwarding and content retrieval procedure*

Generally, in CCN for communication we consider 2 types of packets,

- Interest packet
- Content packet

When a client needs a particular chunk of information, it initiates an interest packet in which client specifies name of interested packet. When it reaches to a region of a particular node, it can perform one of following actions:

i. If requested content is available in its CS-Node then it can directly forward the content packet to the requested node. This reduces the client response time and cache hit rate increase.
ii. If content is not available in its CS-Node then PIT is searched if row already exists then it's updated with port number of requesting node otherwise a new row is updated in PIT with Interest packet and requesting node.
iii. If exact matching entry are not found in PIT then FIB is searched and interest packet is forwarded on the path towards CS-Local Proxy Server [5].
iv. If content found in CS-Local Proxy Server, content packet is returned.
Otherwise
v. PIT is updated and FIB is searched and interest packet is forwarded on the path towards CS-Gateway router. On its path if it's found nearby CS-Proxy Server, content packet is returned.
Otherwise
PIT is updated and Interest packet is forwarded to CS-Gateway router.
vi. GR would search Index Table and find if any of the PS contents the details. If found Interest packet is forward to CS-PS^n and PIT is updated.
Otherwise
if not found the then CS-GR is searched.
vii. If content found in CS-Gateway router, content packet is returned. Otherwise nearby CS-Gateway router is searched and if found return it to respective CS-Gateway router otherwise its forwarded to main content server.

B. *Example of Interest packet forwarding*

Figure 3 explains how interest packets floats around network, retrieves content packet "A" and returns.

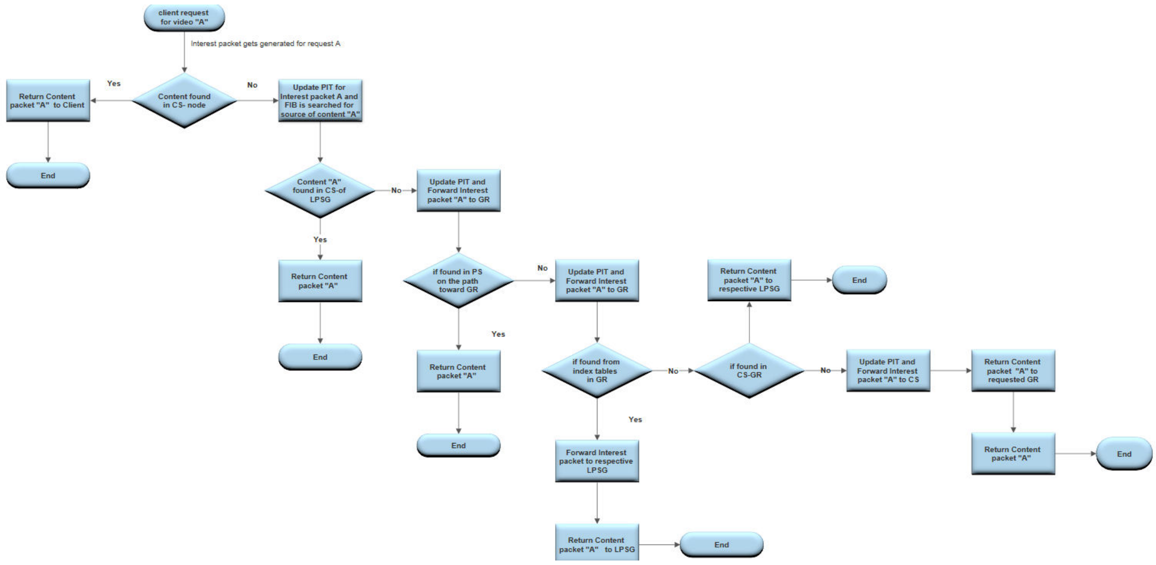

Figure 3: Retrieval of Content packet for Interest packet "A"

Different cases when data packet reaches to a node,

Case 1: when data packet arrives at CS-Gateway Router from central server.

After receiving content packet at CS-Gateway Router, PIT entry is deleted from Gateway Router and then forwards it to local proxy server. This gets stored in cache of CS-local proxy server and then returned to client.

Case 2: when data packet arrives from nearby CS-proxy server to requested CS-proxy server.

After receiving content packet from nearby CS-proxy server, PIT entry is deleted from local proxy server and then forwards it to local proxy server. This gets stored in cache of CS-local proxy server and then returned to client.

Case 3: when data packet is identified from the index table-GR and it arrives from identified CS-proxy server to requested CS-proxy server.

After receiving content packet from identified CS-proxy server, it to local proxy server and PIT entry is deleted from local proxy server. This gets stored in cache of CS-local proxy server and then returned to client.

Case 4: when data packet arrives CS-proxy server to requested CS-node.

After receiving content packet from CS-proxy server, PIT entry is deleted from node. This gets stored in cache of CS-node and then returned to client.

V. CACHING STRATEGY

Leave copy everywhere (LCE) is the default techniques generally followed in CCN. Maintaining the same copy of data everywhere becomes redundant thus reduces the cache size that can be used for storing other content and bandwidth usage also increases. To overcome these caching problems, we have suggested to cache data majorly at local proxy server and gateway router. This way we can store more content in cache that increases the cache hit rate, reduces the client waiting time and reduction in bandwidth usage.

VI. SIMULATION RESULTS

The main focus of this approach is to minimize the client waiting time by sharing the load among proxy server and gateway router nodes. Figure 1 shows that all requests are served either by local proxy server and gateway router nodes for a received time. Our approach has achieved 80% of a high cache hit rate for stored multimedia content when compared to leave copy where (LCE), LCE takes 57% of time to respond to client request thus increasing the client waiting time. In PSGR only 20% of contents are downloaded from the main server.

Bandwidth utilized by network for serving the requests is less, figure 2 shows reduction in bandwidth utilization to 20Mbps in PSGR while LCE would take 55-60 Mbps. For the very first-time bandwidth utilized is more for downloading it from main server. In LCE for each request contents are searched in all the nodes resulting in extra usage of bandwidth when compared to PSGR. Thus, PSGR is better than LCE.

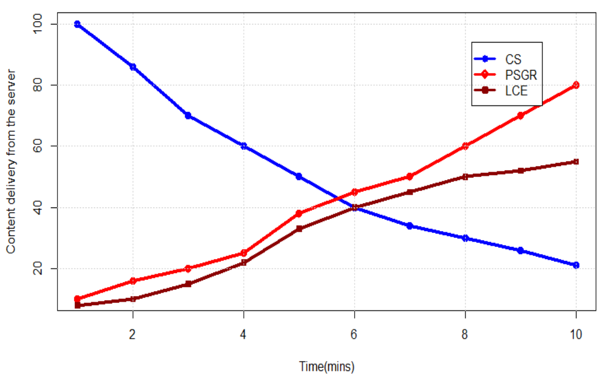

Figure1: Average cache hit rate of CS, PSGR and LCE algorithms

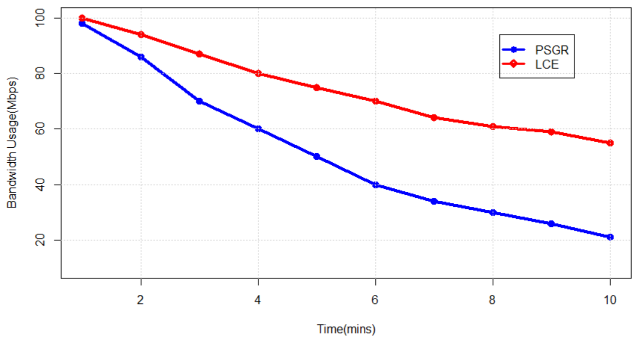

Fig 2: Average Bandwidth utilized by PSGR and LCE algorithms

VII. CONCLUSION

The two tier PSGR architecture increases the cache hit rate to serve maximum number of user request from within local proxy server group or nearby proxy server or help of index table or from outside gateway router thereby reducing the chance of forwarding request to central server thus reducing the network bandwidth usage. Thereby improves the overall performance of network. Hence PSGR is better approach for handling multimedia applications.

VIII. REFERENCES

[1] "CCN Wikipedia." [Online]. Available: https://en.wikipedia.org/wiki/Content_centric_networking. [Accessed: 28-Feb-2019].

[2] "IEEE Spectrum." [Online]. Available: https://spectrum.ieee.org/telecom/internet/a-better-way-to-organize-the-internet-contentcentric-networking. [Accessed: 20-Feb-2019].

[3] G. P. Mishra and M. Dave, "2015 Fifth International Conference on Communication Systems and Network Technologies A Review on Content Centric Networking and Caching Strategies," *2015 Fifth Int. Conf. Commun. Syst. Netw. Technol.*, pp. 925–929, 2015.

[4] M. A. Yaqub, S. H. Ahmed, Á. D. Á. Ccn, and Á. N. D. N. Á. Pub, "Information-Centric Networks (ICN)," pp. 19–33.

[5] G. P. Mishra and M. Dave, "Cost Effective Caching in Content Centric Networking," *Proc. 2015 1st Int. Conf. Next Gener. Comput. Technol. NGCT 2015*, no. September, pp. 198–202, 2016.