IOSR Journal of Computer Engineering (IOSR-JCE)
e-ISSN: 2278-0661,p-ISSN: 2278-8727, Volume 24, Issue 2, Ser. III (Mar. –Apr. 2022), PP 14-21
www.iosrjournals.org

Coordination and Non-coordination Caching Placement Algorithms in Named Data Network for Video on Demand Services

Rasha Saleem Abbas, Shahrudin Awang Nor, Amran Ahmad
[1]*InterNetWorks Research Laboratory, School of Computing, Universiti Utara Malaysia, 06010 UUM Sintok,*
[2]*Computer Science Dept., College of Sciences for Girls, University of Babylon, Babylon, Iraq,*

Abstract*—Recent work on Information-Centric Networking (ICN) enables the next generation of routers to take advantage of caching tools. Named Data Networks (NDN) have recently been proposed as a promising paradigm for the Internet of the future due to their built- in caching and name-based routing for effective content distribution. Research on NDN caching remains a preliminary issue for now. NDN caching researches are preliminary concern currently. Caching placement algorithms was analyzed for Video on Demand (VoD) services for more in-depth excavation. Caches typically store all items, but video archives and the recent upgrade to information- centric networks have made you wonder how it could be useful for cooperative caching. The object is served as chunks that are stored either coordination or non-coordination between multi-routers by partitioning the cache storage. The analytical results proved that the cooperative cache strategy is best then the independent cache strategy for VoD services.*

Index Terms*—Information-Centric Network, Name Data Network- ing (NDN), Cache Placement Algorithms, Video on Demand (VoD).*

Date of Submission: 02-04-2022 Date of Acceptance: 15-04-2022

I. Introduction

A shift is being witnessed by the Internet with a move from the conventional host-to-host communication system to a content distribution platform. Specifically, a large percentage of Internet traffic encountered nowadays is fundamentally hosted- and/or location-independent, asides from the other traditional applications requiring machine-to-machine or point-to-point connections (such as Teletype Network (TelNet), Secure Shell (SSH), Voice over Internet Protocol (VoIP)) [1], [2], [3].

This Internet traffic embodies examples which include the transfer of data in bulk, web, distribution of video, not forgetting the current advances and trends on social networking platforms. In order to accommodate the importance of introducing a content- oriented Internet, recent studies conducted by researchers have put in a considerable effort into reconsidering Internet architecture bearing in mind that the dominant usage pattern is user-to- content traffic. Information-Centric Networking (ICN) being a unique networking paradigm, prioritizes content at the forefront of any communication initiated between random dual users of the system, without paying attention to concepts of host- and location-identifiers [1], [2], [3].

In ICN, the naming of contents is done in a unique and explicit manner and this makes it possible for users to make requests for contents based on the unique identifiers for the content rather than the node identifiers adopted traditionally which is used in Internet Protocol (IP) addresses [4]. Provision of communication and storage is made possible by ICNs enabling many nodes, particular the nodes that are near the end users. Specifically, at this edge, direct connection of nodes with each other is made possible with access to content locally whenever it is available [5]. To accommodate the required changes in network architecture, several different architectural approaches have already been proposed. Examples include TRIAD, CBCB, DONA, 4WARD, NetInf, PSIRP, MobilityFirst, SAIL, CONET, COMET, PURSUIT, CONVERGENCE, and NDN [6], [7], [5].

This literature analyzation contains related areas of research that have been carried out by other researchers with respect to the current subject matter. The organization of the paper follows thus; Section 1 of in-network caching broadly classifies NDN caching into two main caching which are on-path caching and off- path caching. While that the system architecture of NDN contains Content Store (CS), Pending Interest Table (PIT), and Forwarding Information Base (FIB), with services of the NDN system being routed and cached.

Further, on path caching contains multi types as explained in II-B. Besides, the Subsection of the cached content problem analytical is III-A. While Subsection III-B is to analysis the co- ordination caching scheme design by comparing between the co- ordination structure and both two structures of non-coordination. Furthermore, Section V gives an insight into the conclusion.

II. IN-NETWORK CACHING

The research community has shown considerable interest and attention on the subject of in-network caching in particular. In comparison to conventional caching approaches, like hierarchical- caching and proxy-caching, which place large dependence on overlay architectures. In-network caching focuses more on critical network operations. One of caching challenges is what is experienced when NDN caching occurs at network routers, which means it is being experienced at line-speed. This line-speed operation brings up concerns of efficiency, while also prohibiting cooperative techniques between cache to cache, or between the control plane and the caches. Studies have proposed various techniques and approaches for solving these unique characteristics of in-network caching operations which significantly differ from existing requirements of Web- and hierarchical-caching [4], [8], [9]. It has been proven in past studies that in-network caching has a significant effect on network performance improvement, by throughput increment, reduction of network traffic and retrieval delay, and congestion collapse save [10].

For this reason, this is accepted broadly as an NDN enhancement. Note that in-network caching is a vital design component, but different from the entire ICN. Observing the general idea, ICN is an essential change to Internet architecture. Hence, there are various schemes of caching as will be explained and shown in Figure 1. The in-network caching has mainly divided to two different types: Off-path caching and On-path caching.

A. Off-path Caching

This is a cache practice in NDN that enables the content evenly distributed to incur more hit ratio. However, there is the need to provide an additional mechanism, routing information and added forwarding strategies. In achieving the off-path, a trade-off is gained by either predicting the benefits of having the options that mitigate evicting popular contents in caches or the high hop crosses. When additional mechanisms are added, hop-counts becomes high. This affects the state of the network and lessens the throughput by negatively altering the latency of the network [1].

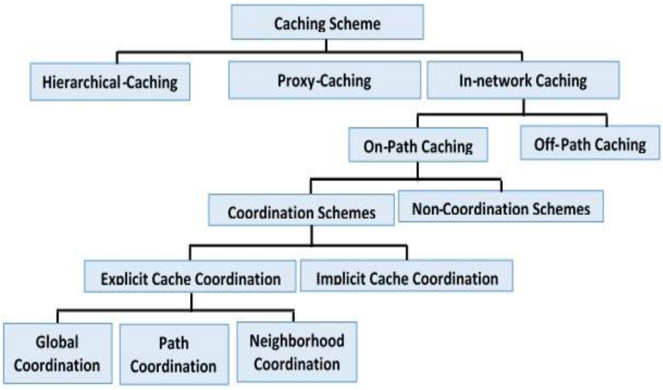

Figure 1.Caching Schemes

B. On-path caching

A most widely used cache practice in NDN. It deploys routers in the network for easy caching of Interest at PIT and data objects in various CS(s). The ability of the caches is thus studied as a predefined condition that enables adequate content availability when requests are posted. NDN promised advantages of the neighbour node producing results, can therefore be achieved when more nodes cache contents based on the frequency of requests or recency of use. In other words, this refers to Least Frequency Use (LFU) or Least Recently Use (LRU) [12]. For on-path caching, additional functionalities are less needed as the provision and intelligent of flooding contents is done with lesser complexity [11].

Another key feature of benefiting content delivery is caching. For NDN, maintaining of caching ability is required from every router, and this is referred to as in-network caching. On-path caching behaviour is displayed when requests are being served, as there will be caching of the data chunk at each router along the path from the producer of the content to the consumer. This behaviour is advantageous in several ways [13], such as:

- **Multicast support:** NDN brings the routers' ability to cache, dissemination of contents can now be handled by edge routers rather than the original producers of the content. This goes a long way toward saving a massive amount of resources in the network.
- **Chunk retransmission:** In order to achieve transport proto- cols being reliable, retransmission of the request occurs to guarantee completion of the transmission. Better efficiency will be recorded if the retransmission of the contents is from the routers that are comparably closer to the end-users than from the originating servers in NDN.

Although on-path caching is beneficial for distribution of content, it still possesses certain shortcomings. The major disadvantage attributed to on-path caching is space wastage because it keeps similar contents at multiple routers. This space problem occurs because when there is data caching at each router on the delivery path, there is a possibility of storing similar replicas all over the network, specifically for the contents that have higher popularity. For this reason, it is a general notion that on-path caching wastes space and this brings about a simultaneous effect of a reduction in the global hit ratio as a result of the contents that are unpopular, hence lowering overall network performance. Based on these shortcomings, a number of caching schemes have been introduced in studies to enhance the performance of in-network caching in NDN [14], [15].

There are two types of caching scheme in NDN; non- coordinated and coordinated. These different types of caching schemed will be introduced in the following subsections with relevant studies that have adopted these approaches [14], [16], [17].

1) Non-coordinated or Independent Caching Policy: Non- coordinated caching means that the routers work individualistically while maintaining their own policies. The routers all run the canonical caching policy on their own and the concept followed is most times based on frequency or request or historical usage. In the study by Chai, et al. [18], a non-coordinated caching algorithm was proposed, which places the contents into specific routers which are selected using betweenness centrality. The inability of non-coordinated caching to make caching decision from global information, it is almost impossible to maximize the caching space properly. Hence, bringing about wastage or lack of maximal utilization of the caching space, with the use of this non- coordinated caching policy. A number of NDN approaches adopt the easiest caching policy, which is the Leave Copy Everywhere (LCE) or on-path caching [19].

2) Coordinated Caching Policy : Coordinated caching means that the routers do not work independently but rather put out a joint effort for the storage of different contents. From the access to the shared information between routers, the coordinated scheme has the ability to make caching decisions with respect to precise performance objectives. Coordinated caching performs relatively better in utilizing caching space than non-coordinated caching. As a result of the limited caching capacity, there is no maintenance of contents that are unpopular in such conditions and there is the probability of a reduction in the global hit ratio being experienced. Another concern that is raised deals with the fairness issue, which seeks an answer to the question of whether every content possesses an equal right in benefiting from the capacity of the cache. Likewise, more traffic overheads will be generated within the network due to the high volume of information being exchanged between the routers. Choosing a criterion for making caching decision may be costly sometimes which in turn brings about impracticability in the deployment of policies. Therefore, coordination schemes are of two types, which are the explicit and implicit cache coordination schemes.

- **Explicit cache coordination schemes**: In this scheme, it is needed to have prior knowledge of the content access frequency, the topology of the cache network, and the state information of the network cache. This is required in order to be able to make placement decisions about content. With respect to making these decisions, this explicit coordination scheme can be further classified to work in three forms:

1) Global coordination: which means that all the cache nodes are involved in the decision.
2) Path coordination: which means that the cache nodes along the path between the producer and consumer are involved in the decision.
3) Neighbourhood coordination: which involves all the cache node neighbours in the decision.

This explicit approach is typically accomplished through the insertion of the required information for coordination into the request chunk for content. For example, the needed information may either be each cache node’s status or the frequency of the requested object at every cache node. At the point where a request is received, the hit node will use the obtained information in computing the optimal policy for placement of content. A coordination scheme that considers multiple paths information was introduced in the work of Chai, et al. [20]. The cache decision is made based on the Betweenness Centrality.

- **Implicit cache coordination schemes:** In this scheme, it is not necessary for every cache node to have prior knowledge of the status of the other cache nodes. This implies that just limited information is shared between the nodes before a decision on the placement of content is made. Similar implicit coordination approaches are the Leave Copy Down (LCD) [21], [22], [23] and Move Copy Down (MCD) [24]. Whereas, MCD on the other hand addresses copy redundancy more seriously, such that the object of the originating hit node will be dropped and the copy would be only kept at the closest router to the requester. One property these two approaches have in common is the pulling of objects down to the edge network. Another approach takes the concept of probability into consideration, that is the Probabilistic Cache (ProbCache) [25].

III. METHOD

Based on the above discussions on the classification of cache coordination into either implicit or explicit according to the degree of autonomy in making cache decision, It can be concluded that the explicit-cache coordination scheme using path coordination is more proper to VoD.

A. Analysis of Content Placement Problem Model

A content placement issue is formulated in this section, and an analysis is performed. The content placement issue refers to how the chunks are distributed to the cache nodes to maximise the full benefits of the cache within the specified space limits.

Each cache node stores data that passes but the server has all the content. The servers/users don't separated from the cache node adjacent to them for simplicity. All chunks have the same size as the basic cache unit. There is just one database of origin which is a server, n_c collectively V, for all chunks. The Interest chunk forwards depending on FIB's forwarding entry, that defines through certain strategies of routing. Each R_i is a router contains a restricted $C(i)$ capacity of cache. Furthermore, without generality loss, assuming that every R_i node delivers request messages (Interest chunk) at a rate of $\lambda_{c,i}$ with a percentage of P_c of requesting chunk c. Therefore, $\lambda_{c,i} * P_c$ demonstrates the frequent request of chunk c at router R_i.

Here, the concept of content placement benefit is introduced, that demonstrates the reduction in path length due to cached content. For instance, chunk c is is requested from router R_c and forwarded for its original server n_c. Hence, path $(R_c, n_c) = R_c, ..., n_c$ is the forwarding path of the request between R_c and n_c. If an intermediate cache router R_i is satisfied the request message, then the path will be decreased to $R_c, ..., R_i$. Thus, the reduced length $R_i, ..., n_c$ is demonstrated as the benefit $b_{c,i}$ of content placement. The path length value equals to the hop count from the caching router to the server on the distribution path. Note that, $b_{c,i}$, is a positive integer if R_i is on the path (R_c, n_c). Apparently, if R_i not in the path (R_c, n_c), then $b_{c,i}$ equals to zero.

Table I
RELATED PARAMETERS IN MODEL

Notation	Definition
$\lambda_{c,i}$	The average of request ratio for chunk c at router R_i.
P_c	The percentage of request for chunk c.
$b_{c,i}$	The hop distance reduction to cache the chunk c at router R_i for request chunk R_c.
$d_{c,i}$	The binary variable show whether cache chunk c on router R_i.
V	The cache nodes set.
C	The total number of chunks.
C(i)	The maximum cache capacity of router R_i, taking chunk as the unit.

The optimization model has been built for the problem of content placement in NDN as follows, derivative by the literature by the literature [26]. Table I contains some important quotations concerned to the proposed model in order to further discussion smoothly. An optimization model for the content placement problem in NDN is constructed as follows:

$$\text{Max} \sum_{i \in V} \sum_{c \in C} \lambda_{c,i} \cdot P_c \cdot b_{c,i} \cdot d_{c,i} \tag{1}$$

$$\text{c.t} \sum_{c \in C} P_c = 1 \tag{2}$$

$$d_{c,i} = 0/1 \tag{3}$$

$$\sum_{c \in C} d_{c,i} \le C(i) \tag{4}$$

Where n_i is the node that cache the chunk c with the average request rate of this chunk $\lambda_{c,i}$. P_c refers to the probability of chunk c to be available, that reflects the popularity of the chunk. $b_{c,i}$ refers to the benefit of placement caching chunk c at node R_i for the request from node R_c. While $d_{c,i}$ denotes to a binary variable which equals to 1 if the chunk c caches at node R_i. In conclusion from Equation 4, the capacity is a constraint for each cache node; hence, the proposed cooperative caching is needed.

B. Analysis of Coordination Caching Scheme Design

The performance of the proposed cooperative caching approach is now analysing based on a theoretical perspective. Overall, the performance metric is the rate of a cache miss. Therefore, the performance of excellent system gives little cache miss ratio.

The simplified design of the proposed cooperative caching method in NDN was compared (represented in Figure 2) with two caching methods which are the parallel structure of k CRs (see Figure 3) and k CRs connect in a series circuit (see Figure 4).

The proposed cooperative caching design with k homogeneous caches working together in Figure 2 to theoretically analyse the caching performance of the collaborative caching architecture and non-cooperative caching architecture. Based on this analysis, the significant characteristic time τ_i identify of caching, λ is a function of processing of request arrival. In contrast, C is the cache size, as well as the pattern of request. There are two concepts for the design of hierarchical caching, which are categorised according to the filtering definition defined at the appropriate time. These principles of designing are then employed to manage the structure of the cooperative caching. The performance of the proposed structure design establishes to be superior to the structures of traditional hierarchical non-cooperative caching, as shown below:

Every cache-store separates chunks and creates a group of cooperative cache size $k * C$. The LRU replacement strategy is used on every single cache to ensure that each group of CRs evicts its video file at the same time. Although the collaborative caching placement algorithm group is not precisely at the same time on each router in the group, thus, the delivery rate of the users' requests at the approximating single cache is $k * \lambda_i$. In conjunction with Che Y. et al [27], the cache miss rate created by the cooperative group is defined as $\lambda' = k * \lambda_i e^{-k\lambda_i \tau'_i}$.

The first structure is individual parallel cache as in Figure 3, homogeneous caches k of a cache size C are linked to a server. Every cache deliver a requests of video chunk i with a request rate equal to λ_i. A cache miss occurs when chunk i is not in cache. The cache miss ratio of chunk i is represented as λ^0. Thus, the ratio of the total cache miss for the k caches is $\lambda = k.\lambda^0 = k.\lambda_i e^{-\lambda_i \tau_i}$.

where τ_i is the maximum interarrival time of the chunk i between two neighbouring cache hits. [27].

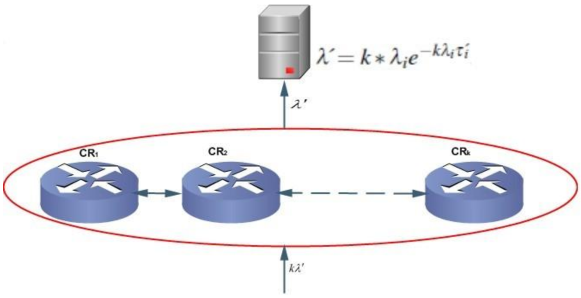

Figure 2.Coordinated Caching

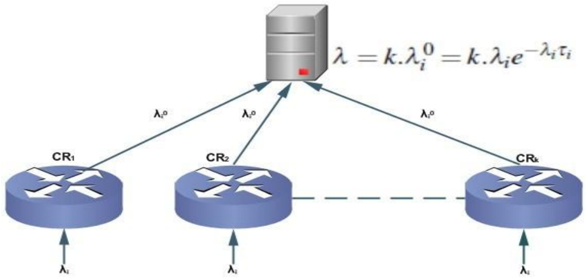

Figure 3. Non-coordinated Parallel Cache

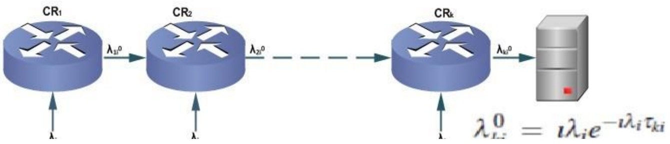

Figure 4. Non-coordinated Cache in Series

Proposition 1. Coordinated caching achieves at least the similar performances as the non-coordinated parallel caches.

Proof: In order to prove that $\lambda \geq \lambda'$ for any $k \in N$ and $C \in N$.

This proof was began from the fact that the function $ʃ(\tau_i) = e^{-\lambda_i \tau_i}$ is continuous and monotonically decreasing. The function $u(\tau_i)=\sum_{j=1,j\neq i}^{N} e^{-\lambda_i \tau_i}$ is also continuous and steadily over time decreasing since $u(\tau_i)$ is the sum of $ʃ(\tau_i)$. According to [27], τ_i and τ_i' can be derived by the specific these Equations:

$$\sum_{j=1,j\neq i}^{N} (1 - e^{-\lambda_i \tau_i}) = C$$

$$\sum_{j=1,j\neq i}^{N} (1 - e^{-k\lambda_i \tau'_i}) = kC \qquad (5)$$

Since $C \in N$, and $k \in N$ then obtaining

$$\sum_{j=1,j\neq i}^{N} e^{-\lambda_i \tau_i} \geq \sum_{j=1,j\neq i}^{N} e^{-k\lambda_i \tau'_i}$$

As $u(\tau_i)$ is monotone reducing, it can be concluded that $\tau_i < k\tau'_I$. Because $ʃ(\tau_i)$ is also monotone reducing, to know that

$$e^{-\lambda_i \tau_i} \geq e^{-k\lambda_i \tau'_I} \qquad (6)$$

Multiply both sides of Equation (6) by $k\lambda_i$. The proof follows.

The second structure is the non-coordinated cache in series as demonstrated in Figure 4. For each cache, the request ratio i from the customer is still identical and denoted as λi. The missed stream forwards to the next-hop cache on the path to the server, instead of forwards it straight to the server. The missed stream λ_{ki}^{0} of the cache k is the missed of the multi-cache stream system, because of only the kth cache linked to the server. Therefore, discovering the expression of λ_{ki}^{0} is the convergence point. It is not easy to conclude λ_{ki}^{0}, even though the structure is simple since that the exact distribution function of the missing stream $ʃ_{ki}^{0}(t)$ includes an infinite number of terms [27]. Consequently, the precise miss ratio cannot be deduced due to computational complexity. However, the delivering request ratio at the kth cache is $\lambda_{ki} = \imath . \lambda_i$, where ı is a constant and $1 \leq \imath \leq k$. Let the miss rate be a function $ʃ_{ki}^{0}$ of λ_i , to have $ʃ_{ki}^{0} = \lambda_{ki}^{0} = l\lambda_i e^{-l\lambda_i \tau_{ki}}$ · Recall that the miss ratio of coordinated caching is $ʃ'_i = \lambda' = k^* \lambda_i e^{-k\lambda_i \tau'_i}$

Proposition 2. Coordinated caching achieves, at most, the similar max miss rate as the non-coordinated caches in a series.

Proof: In order to prove that, for any $C \in N$, and $k \in N$ since have $\max(ʃ_{ki}^{0}) \geq \max(ʃ'i)$. The value of τ_{ki} can be delivered as following:

$$\sum_{j=1,j\neq i}^{N} (1 - e^{-\lambda_i \tau_i}) = C$$

$$\sum_{j=1,j\neq i}^{N} (1 - e^{-l\lambda_j \tau k_i}) = C \qquad (7)$$

Instead of directly comparing τ_{ki} with $\tau'i$, another variable $\tau'i$ was used to setup the below Equation:

$$\sum_{j=1,j\neq i}^{N} (1 - e^{-k\lambda_j \tau'_i}) = C \qquad (8)$$

Since $k \geq \imath$, combining Eqs. 7 and 8, We have $\tau_{ki} \leq \tau'i$. Applying the same method as that in the proof of l on Eqs:(8, 6), obtaining that $\boldsymbol{\tau'_I \leq \tau''_i \geq \tau_{ki}}$. The first deviation of $ʃ_{ki}^{0} = 0$ is

$$l e^{-l\lambda_i \tau_{ki}} + l\lambda_i \, e^{-l\lambda_i} \lambda_i \tau_{ki} \,.(-l\tau_{ki})=0 \qquad (9)$$

then $\lambda i = (\imath \tau_{ki})^{-1}$. The second derived of $ʃ_{ki}^{0}$ is less than zero, so

$$\max(ʃ_{ki}^{0})=(e\tau_{ki})^{-1} \qquad (10)$$

similarly,

$$\max(ʃ_i^{'})=(e\tau'_i)^{-1} \qquad (11)$$

Since $\tau_{ki} \leq \tau'_i$, then it can be conclude that

$$\mathrm{Max}(ʃ'_i) \geq \mathrm{Max}(ʃ'_i) \qquad (12)$$

Notice that the exponential value of $ʃ'i$ reduces more speedily than $ʃ_{ki}^{0}$, which indicates that the proposed coordination caching has at least the similar performance of highly requested videos and better performance of medium requested videos. The proposed cooperative placement caching is, therefore, stronger than the non-cooperative replacement caching. To sum up, both parallel and series non-coordinated models are less effective than a proposed coordinated model. It expects that the proposed design, which combines collaborative and series methods, will outperform the standard NDN policy.

IV. Result

In the following sections, we compare algorithms and analyze the effects of individual algorithmic extensions. We use randomized block design where each algorithm is run on the same test cases and observed votes. We will refer to one of these comparisons as an experiment. Our analyses uses ANOVA with the Bonferroni procedure for multiple comparisons statistics [McClave and Dietrich, 1988). In the tables that follow, the value in the last row is labeled RD for Required Difference. The difference between any two scores in a column must be at least as big as the value in the RD row in order to be considered statistically significant at the 90% confidence level for the experiment as a whole. As a visual aid, a score in boldface is significantly different from the score directly below it in the table.

V. Conclusion

A main feature of the Information-Centric Network is that each router is equipped with a caching capability that enables several small pieces of equipment to store content. The analysis of these algorithms is specially designed for large scale video stream delivery. The advantages validated of the coordinated caching using theoretical analysis by comparing it with two caching non- coordinated models which are the parallel structure of CRs, and CRs connect in a series circuit. Finally, based on this analysis, the significant characteristic cache is identified for a VoD service, which is a cooperative cache algorithm. In terms of VoD, the efficiency of this coordinated architecture is found to be better than the typical non-coordinated caching architecture.

References

[1]. A. D. Greenberg and J. Zanetis, “The Impact of Broadcast and Streaming Video in Education,” Cisco: Wainhouse Research, vol. 75, 2012.

[2]. D. Applegate, A. Archer, V. Gopalakrishnan, S. Lee, and K. K. Ra- makrishnan, “Optimal Content Placement for a Large-Scale VoD System,” IEEE/ACM Transactions on Networking, vol. 24, no. 4, pp. 2114–2127, 2016.

[3]. A.-M. Khan Pathan and R. Buyya, “A Taxonomy and Survey of Content Delivery Networks,” Grid Computing and Distributed Systems Laboratory, University of Melbourne, Technical Report, vol. 4, pp. 1—-44, 2007.

[4]. L. Saino, I. Psaras, and G. Pavlou, “Icarus: a Caching Simulator for Information Centric Networking (ICN),” in Proceedings of the 7th Inter- national ICST conference on Simulation Tools and Techniques, (Lisbon), pp. 66–75, ICST (Institute for Computer Sciences, Social-Informatics and Telecommunications Engineering), Mar. 2014.

[5]. J. Khan, C. Westphal, and Y. Ghamri-doudane, “A Popularity-aware Cen- trality Metric for Content Placement in Information Centric Networks,” in ICNC 2018-International Conference on Computing, Networking and Communication, (Maui, HI), p. 8, IEEE, Mar. 2018.

[6]. Content-Centric Networking Packet Level Simulator [Online]. Available: https://code.google.com/p/ccnpl-sim/, 2012.

[7]. CCNx [Online]. Available: http://www.ccnx.org/.

[8]. N. Fujita, Y. Ishikawa, A. Iwata, and R. Izmailov, “Coarse-grain replica management strategies for dynamic replication of Web contents,” Computer Networks, vol. 45, no. 1, pp. 19—-34, 2004.

[9]. X. Jiang, J. Bi, G. Nan, and Z. Li, “A survey on Information-centric Networking: Rationales, designs and debates,” China Communications, vol. 12, pp. 1–12, July 2015.

[10]. R. S. Abbas, S. A. Nor, and A. Ahmad, “A review of cache placement algorithms for video on demand in named data networking,” Journal of Advanced Research in Dynamical and Control Systems (JARDCS), vol. 10, p. 1322–1332, Sept. 2018.

[11]. I. Abdullahi, S. Arif, and S. Hassan, “Content Caching in ICN Using Bee- Colony Optimization Algorithm,” Advanced Science Letters, vol. 21, no. 11, pp. 3536–3540, 2015.

[12]. S. J. Taher, O. Ghazali, and S. Hassan, “A review on cache replacement strategies in named data network,” Journal of Telecommunication, Electronic and Computer Engineering (JTEC), vol. 10, no. 2-4, pp. 53–57, 2018.

[13]. C. Y. Chang and M. S. Chang, “A Hybrid Coordination Approach of In- network Caching for Named Data Networking,” International Journal of Future Generation Communication and Networking, vol. 9, no. 4, pp. 285–300, 2016.

[14]. G. Zhang, Y. Li, and T. Lin, “Caching in information centric networking: A survey,” Computer Networks, vol. 57, pp. 3128–3141, nov 2013.

[15]. B. Ahlgren, C. Dannewitz, C. Imbrenda, D. Kutscher, and B. Ohlman, “A survey of information-centric networking,” IEEE Communications Maga- zine, vol. 50, no. 7, pp. 26–36, 2012.

[16]. Y. Kim and I. Yeom, “Performance analysis of in-network caching for content-centric networking,” Computer Networks, vol. 57, pp. 2465–2482, sep 2013.

[17]. M. Gallo, B. Kauffmann, L. Muscariello, A. Simonian, and C. Tanguy, “Performance evaluation of the random replacement policy for networks of caches,” Performance Evaluation, vol. 72, pp. 16–36, 2014.

[18]. W. K. Chai, D. He, I. Psaras, and G. Pavlou, “Cache “Less for More” in Information-Centric Networks,” in International Conference on Research in Networking, pp. 27–40, Springer, 2012.

[19]. C. Dannewitz, D. Kutscher, B. Ohlman, S. Farrell, B. Ahlgren, and H. Karl, “Network of information (NetInf)-An information-centric networking archi- tecture,” Computer Communications, vol. 36, no. 7, pp. 721–735, 2013.

[20]. W. K. Chai, D. He, I. Psaras, and G. Pavlou, “Cache “Less for More” in Information-Centric Networks (Extended Version),” Computer Communica- tions, vol. 36, no. 7, pp. 758–770, 2013.

[21]. N. Laoutaris, S. Syntila, and I. Stavrakakis, “Meta Algorithms for Hier- archical Web Caches,” in Performance, Computing, and Communications, 2004 IEEE International Conference on, (Phoenix, AZ, USA), pp. 445–452, IEEE, Apr. 2004.

[22]. S. H. Lim, Y. B. Ko, G. H. Jung, J. Kim, and M. W. Jang, “Inter-chunk popularity-based edge-first caching in content-centric networking,” IEEE Communications Letters, vol. 18, no. 8, pp. 1331–1334, 2014.

[23]. C. Fricker, P. Robert, J. Roberts, and N. Sbihi, “Impact of traffic mix on caching performance in a content-centric network,” arXiv preprint arXiv:1202.0108, pp. 1—-12, 2012.

[24]. I. S. Nikolaos Laoutaris, Hao Che, “The LCD Interconnection of LRU Caches and its Analysis,” Performance Evaluation, vol. 36, no. 7, pp. 609–63, 2006.

[25]. I. Psaras, W. K. Chai, and G. Pavlou, “Probabilistic In-Network Caching for Information-Centric Networks,” in Proceedings of the Second Edition of the ICN Workshop on Information-centric Networking - ICN ’12, (Helsinki), pp. 55–60, ACM, Aug. 2012.

[26]. Y. Wang, Z. Li, G. Tyson, S. Uhlig, and G. Xie, “Design and evaluation of the optimal cache allocation for content-centric networking,” IEEE Transactions on Computers, vol. 65, no. 1, pp. 95–107, 2015.

[27]. H. Che, Y. Tung, and Z. Wang, “Hierarchical web caching systems: Modeling, design and experimental results,” IEEE Journal on Selected Areas in Communications, vol. 20, no. 7, pp. 1305–1314, 2002.

Rasha Saleem Abbas, et. al. “Coordination and Non-coordination Caching Placement Algorithms in Named Data Network for Video on Demand Services.” *IOSR Journal of Computer Engineering (IOSR-JCE)*, 24(2), 2022, pp. 14-21.