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Time Dependent Popularity Caching Scheme for NDN Based MANETs

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ABSTRACT

Named data networking (NDN) approach has natural benefits within Mobile Ad hoc Network (MANET) but presents different issues as well. Space for cache, energy, and mobility of devices in a MANET is limited; therefore, we need for an enhanced judgement concerning which data to be store and where to be cache. A Time dependent Popularity Caching Scheme (TDPC) has suggested which selects nodes for caching the content on the forwarding path of packet and chooses the contents which have cached constructed on their time dependent popularity. At this interval, the cache distribution of the content and the storage capability of the devices are also measured. Results of the suggested TDPC approach are evaluated by using the simulator ndnSIM which is beached on Network Simulator 3 (NS-3). Simulation outcomes show that TDPC has good performance in expression of cache hit ratio, content retrieval interval, total cache copies and compared to the Dynamic Caching Strategy for CCN-based MANETs (CSCM). The goal of TDPC is to reduce cache redundancy, retrieval time of content and total number of cache copies.

KEYWORDS: Mobile ad hoc Network, Redundancy, Time Dependent Popularity, Content Store, Interest, Data

1. INTRODUCTION

Today, architecture of Internet is depending on TCP/IP model where communications are detained using devices or machines mac addresses. It is difficult to modernise today Internet architecture and additional improve its communication constraints. Moreover, the TCP/IP model has numerous weaknesses (security, location dependent and incompetent resource utilization). Now, the number of wireless devices has augmented sharply due to the rapid growth in technology. NDN approach will be principally useful in remote specially appointed systems administration environment [1].

MANET is infrastructure-less and uninterruptedly self-configuring network. The dispersed network, missing central administrative entity and comprises mobile devices which have dynamic and random movement in the network shown in the figure 1. In this network, every mobile device communicates within its range devices. Maximum routes used in MANET are multi-hop [2]. In short, MANET is an unpredictable network due to continuous dynamic nature of its mobile devices. With the development in the mobile devices, MANET is measured to be an important part of smart communication. Mobile devices exchange information with each other within their own specific range. In NDN based MANET, the joining mobiles are functioned in extremely active and challengeable atmosphere such as limited power of battery, frequency variations, sporadic connectivity, etc. NDN based MANET has been faced some serious issues which are data redundancy, inconsistency, mobility, crashes of packet, packet flooding and retransmissions of packet. These issues reduce the good results of the NDN based MANET [3].

Mobile devices can impart upheld what data they need, rather than computing a way to accomplish selection of hub. It might expressively change the implementation for the subsequent causes. In NDN the IP addresses are not assign to the nodes, it use the names of data and forward the Interest Packet base on the name of data which it is required and receive the data packet base on this name [4].

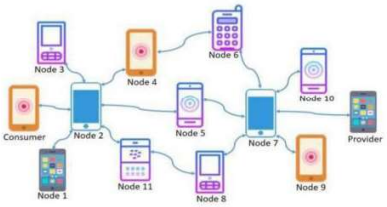

Figure 1. MANET Architecture

As a result of this data name primarily based style doesn't have routing circles, Interest Packets have been forwarded on several methods towards prospective data positions; just in case quite one way yields the demanded data, a node will measure that path provides the most effective performance and send upcoming Interest for identical data foundation in this direction solely [5]. This multi path methodology is especially useful in ad hoc networks as a result of the utilization

of multiple ways removes the vital dependency on pre computed single ways, therefore relaxed the rigorous necessities on the appropriateness of routing informs and routing state reliability between all the nodes.

We have proposed more effective networking caching scheme constructed on Time Dependent Popularity Caching (TDPC) to increase performance of cache of NDN based MANET in this paper. This approach creates filled procedure of the popularity of the data, and then selectively stores the data contents according to their popularity level by calculating the previous popularity with respect to time. This increases the usage of the store resources, and reductions rate of the data contents replacement. It evades the similar caching of content on the contiguous nodes, decreases the volume of redundant content in the network, raises the multiplicity of content and increases the hit ratio of cache. The main aim of TDPC caching scheme for the NDN based MANET to evades the similar content caching on the contiguous nodes, decreases the volume of redundant content in the network, rises the multiplicity of content, increases the cache hit ratio and to store the data locally.

The recap of this research paper is structured as follows. Segment II introduce the literature work. The complete TDPC scheme is explained in segment III and the simulation atmosphere and results are shown in segment IV. Lastly, segment V completes the paper.

2. RELATED WORK

Although several scholars have been suggested different NDN architecture for wireless networks, well-organized caching scheme of NDN based MANET are quiet challenging issues. Placement of content in cache focuses on when and where to place the copies. This section provides the summary of caching approaches in the NDN based MANET.

In literature [6], this has planned that the distributed caching schemes for ad hoc networks that either nodes have been created for caching the popular contents which permissions through or noted the forwarding route for data towards direct upcoming demands. The thought of dissimilar caching content on the neighbourhood had additionally subjugated in [7], wherever routers through alike interests and arrangements of mobility area unit classified along to enhance the hit ratio of cache. In literature [8], this has planned a caching decision scheme supported the responsiveness for data that have been stored on the neighbour nodes, targeting of distinguishing the caching data on the other nodes in network. The caching of content has been studied within the sporadically associated MANET likewise; a cooperative based caching mostly content distribution structure had planned. In literature, a cooperative caching technique was planned supported the broadcasting in environment of a radio network to boost the accommodating cache improvement. In [9], a content management design had planned for NDN based MANET, that finite the content and its physical position, and cached the contents that additional common intensively.

The construct of NDN has been introduced within the Vehicular ad hoc network (VANET) [10], discovered the social based cooperation policy between vehicles within the VANET and planned the cooperative caching supported the supplementary of corporation and messenger to boost the NDN caching performance, to enhance the consumer QoE on the multimedia system streaming facility. Considering the enough cache space, energy, vehicles, and transmission of data facility within the VANET had suggested in [11] to thrust the content to vehicles for pre-emptive caching. Within the lightweight of current improvements, caching on the corner positions in mobile cellular networks had been examined. In NDN based MANET, the devises activity as every user and router simultaneously, in this way the data demands approaching on the router envelop not exclusively the data demands delivered without anyone else anyway furthermore the boundless data demands from its neighbour routers. Hence, the prevailing caching analytical models can't be prolonged into NDN primarily based painter directly. During this case, it's essential to derive associate analytical model towards live the inspiration of caching in NDN based MANET tentatively.

To make the Named Data Network (NDN) model better support for Mobile ad hoc Networks, a caching scheme called time dependent popularity (TDPC) has been considered in this paper. Caching conclusion of TDPC drops under the complete deliberation of the data spreading in the network and the nodes cache ability. TDPC make guarantee that the data is close as the likely to the consumer nodes to reduce the data redundancy, increase hit ratio and decrease the content retrieval time.

3. TDPC CACHING SCEHEME

Decent usage of restricted cache in the Named Data Networking based MANET needs watchful calculation that which should be cached. It requires that every content should not cached equally a data cannot be cached on each device on routing path.

Table 1: Interest Packet Format

Field	Description
Name	Name of requested content
Lifetime	Expire time of the Interest which is in seconds
Nonce	Arbitrary value is used to escape repetition of Interests
Hop Count	Contains the distance of consumer to the other nodes

TDPC take two factors into account while making a caching decision on node which are distance of consumer from other nodes and calculated time-based popularity.

3.1 Distance of Consumer from Other Nodes

Separation of consumer from other devices is characterized by number of hop count checks. Complete number of jump tallies characterizes that the number of devices passed by Interest packet. We have putt one more field in the Interest packet which is hop count appeared in Table I. Customer advances Interest packet to the neighbour devices, neighbour device get packet of Interest and checks it's Content Store (CS), If mentioned information is found in content store at that point send back to the consumer device. If information isn't found in content store, neighbour device checks Pending Interest Table (PIT) section for this intrigue packet. Intrigue is essentially disposed of if PIT is as of now there. In any case section into PIT is included for the later reaction of information, increase hop count check an incentive by one and forward intrigue packet to different devices. Jump tally esteem is expanded by one at each device, when a device gets a Data packet as reaction, it will check PIT section for this information. If passage in PIT is discovered, hop count tally esteem is decremented and locale is controlled by utilizing this bounce check esteem. Information packet will be disposed of if section in PIT isn't found. We have included two extra fields in the Data packet appeared in Table II. In the event that bounce tally esteem is one, device is considered closest to shopper hub, thus information is considered for reserving by ascertaining its neighbourhood fame.

3.2 Calculating Time Based Popularity

When provider receives the Interest packet, it extracts the hop count value from packet of Interest, append to packet of Data and Data packet also contains the keywords field. When Data packets receive a relay node first it will check PIT entry in table, if not found then discard Data packet.

Table 2: Data Packet Format

Field	Description
Name	Name of requested content
Length	Requested content length
Content	Actual payload of content
Hop Count	Contains the distance of consumer to the other nodes
Keywords	Data contains keywords
Signature Type	That characterizes the category of signature such as SHA256 etc.

Otherwise, extract keywords from data packet and calculate the time dependent popularity of keywords using following Equation:

$$P(i) = \left\{ \left(\frac{P(i-1)}{1+TF} \right) + IF \right\}$$

P(i) is the current time dependent popularity of keyword, which is calculated previous time-based popularity P(i-1) divided by time factor. Resultant estimation of condition will decide if the substance ought to be cached or not. On the off chance that time subordinate popularity P(i) bigger than certain limit (T), information will be stored in the CS in any case update Time subordinate Popularity Table (TPT) and forward Data packet to different devices in network by utilizing the Algorithm.

TF is the time factor which is in fact the time when the content is last accessed. IF is an impact factor of a content value of which determined by region of current with respect to requester. An area can either be local or global. If hop tally esteem is 1, it is taken a nearby locale else it is viewed as global area. The aftereffect of condition is taken a T to store information. If T is arranging as 5, information might be stored once consequence of this equation is reached to 5. Various estimations of effect are utilized for various areas. Effect factor estimation of nearby area is accepted higher as contrast with global, as we are more intrigued of information getting stored locally, which is more advantageous. We have taken IF esteem 0.25 for global district while 1 for local.

4. EXPERIMENT EVALUATION

In this section we have presented simulation results and demonstrate the performance of TDPC by evaluating it against several performance metrics such as:

- Cache Hit Ratio: Cache hit ratio is the ratio of number of requests, answered by source node to total number of requests generated within the network.
- Content Retrieval Time (CRT): CRT is defined as the time duration when an Interest packet is sent, and when the corresponding Data packet is received.
- Cache Copies: Total number of cache copies that are stored in the network.

Moreover, we have compared the performance of TDPC with A Dynamic Caching Strategy for CCN-based MANETs (CSCM) which implemented on the ndnSIM because there is no work on this research area [9].

Table 3: Simulation Parameters

Parameter	Value
Number of different content	100
Packet Size	1040 Bytes
Technology	IEEE802.11g
CS Size	50
TPT Size	100
Request Rate	20 Req/s
Replacement Policy	LRU
Simulation Time	1000s
Number of Nodes	60
Data Rate	6 Mbps
Popularity T	5
Simulation runs	10

A. Simulation Background

Results of the suggested TBPC approach is measured through using the simulation tools NS-3 and ndnSIM

[14] [15]. In MANET situation, we have taken 60 mobile nodes arbitrarily dispersed in 1000m x 1000m region. For mobility of a node we have been used arbitrary waypoint model. At the start, nodes are static and then start moving arbitrarily after some time to transformation from one point to another point position with the velocity of 10 to 25m/s. Among all mobile devices several are reserved as information supplier device although several are utilized as consumer devices rest are simply filling in as forwarder, halfway or transfer devices. In Interest packet broadcasting from consumer node to provider node we have used the best route strategy for forwarding. The requests for consents are generated by using zipf distribution [16].

All network nodes have consumed the IEEE802.11g technology constructed radio boundaries. Moreover, size of every Data packet is 1040 bytes and 6 Mbps is the data rate. The Simulation parameters are shown in TABLE III.

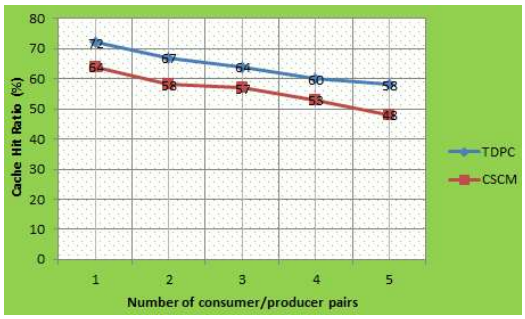

Figure 2. Hit Ratio of Cache

B. Experimentation Outcomes and Examination

Cache Hit Ratio: Figure.2 TDPC shows that hit ratio of cache is better than CSCM in all consumer producer pairs. Hit ratio decreases in both schemes with increase in the number of pairs as cache size to content sample space ratio decreases with increase in consumer producer pairs. Hit ratio in TDPC is better as compare to CSCM as in CSCM every new incoming data replaces existing data in cache, even some infrequently accessing and less popular content can replace some popular and frequently accessing contents. So, this unnecessary replacement causes lower hit ratio in CSCM.

While in TDPC only popular contents for which popularity threshold has been reached will replace existing entries in cache hence avoids unnecessary replacement and improve hit ratio.

Content Retrieval Time (CRT): TDPC CRT is less than the CSCM but increasing with the number of producer and consumer sets. Greater is the hit ratio; better would be content retrieval time as interest is fulfilled by shorter network path.

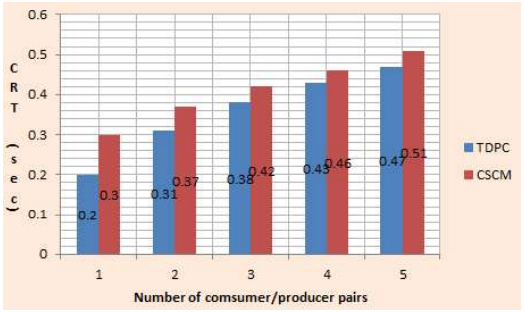

Figure 3. Content Retrieval Time

Since hit ratio is better in TDPC as compare to CSCM, this results as lower content retrieval time in TDPC shown in the Figure.3.

Cache Copies: Number of stored duplicates will increment with increment in producer/consumer sets in the TDPC and CSCM. This is on the grounds that more are producer/consumer combines particularly consumer, more devices will become in extent of correspondence henceforth more will be information duplicates stored. Anyway, TDPC consistently possesses lesser extent of store and this is again on the grounds that TDPC limits store by considering just nearby and worldwide areas as opposed to CSCM where information is stored on all devices on a correspondence way. This is clear from the diagram in Figure 4.

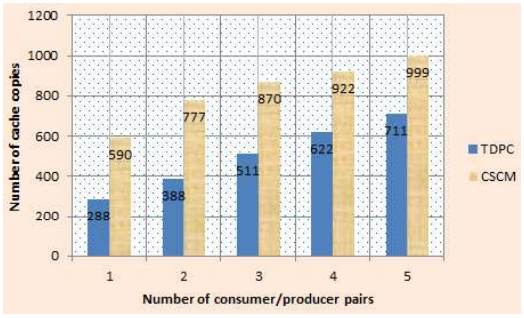

Figure 4. Number of Cache Copies

5. CONCLUSION

NDN based MANET has gain much attention in the recent past. In this paper we have purposed a novel time dependent popularity caching scheme (TDPC) for the NDN based MANET that enhance the MANET's network performance. TDPC caching the popular contents by determining their popularity based on the time. Time and areas are taken as significant factors of time depended popularity estimation. Simulation results shows that major enhancement in hit ratio of cache, retrieval interval of content and total of cache copies in TDPC. The next steps of this work maybe to enhance the network lifetime and handle mobility of the MANET, which are more important and challengeable.

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