

Location-aware on-demand fuzzy clustering based multipath caching and forwarding (LOFCMCF) in Named Data Networking(NDN) based MANETs

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ABSTRACT: Named data networking (NDN) settle the customary TCP/IP based Internet issues (i.e., area needy, complex use, adaptability, poor asset use and so on.) and is considered as a qualified contender for cutting edge Internet worldview. In NDN-based mobile ad hoc networks (MANETs), the partaking hubs are worked in exceptionally unique and test capable condition, for example, low battery control, channel vacillations, discontinuous network et cetera. The proposed location-aware on-demand fuzzy clustering based multipath caching and forwarding (LOFCMCF) convention considers the areas of both a customer and a supplier amid its sending system. A transfer hub advances the Interest or Data parcel just in the event that it has less separation towards the purchaser or supplier hub, individually. The LOFCMCF protocol uses the multipath sending process that has two advantages: first, high unwavering quality is expert for transmitting both Interest and Data parcels. Second, Data bundles pursue numerous courses. Moreover, the sending procedure additionally thinks about the hub's outstanding vitality to enhance the execution of the hubs. Subsequently, content is generally disseminated over the system, which mitigates the substance recovery time for future solicitations. Broad tests along their outcomes demonstrate that proposed convention performs better as contrasting with the other ongoing proposed conventions.

INDEX TERMS—Content, Interest, Named Data Networking(NDN), Information Centric, mobile ad hoc networks (MANETs), clustering, Caching.

1. INTRODUCTION

Mobile communication gadgets require a settled system framework of cell towers or remote switches. Therefore, cell phones might not have benefit when framework is harmed by any reason. In these circumstances, distributed correspondence between these gadgets is one conceivable arrangement. Besides, to expand the scope of correspondences, a multi-bounce arrange is needed. Mobile Ad-hoc Network (MANET) has been utilized in the past to give distributed and multi-jump interchanges [1-2]. The significant difficulties in MANET are versatility and discontinuous availability. Hubs are expected to move at different paces, bringing about quick changing topologies and outrageous parcel misfortunes, and subsequently high overhead for course development and upkeep costs. In addition, the transitory from endure may execution network apportioning [3].

To satisfy the future application prerequisites, peer-to-peer (P2P) and content delivery networks (CDNs) have been utilized as overlay systems [4-5]. In any case, these arrangements are currently viewed as unseemly for the cutting edge applications request point of view and furthermore have numerous downsides. Information-centric networks (ICNs) [6] are a developing idea for future Internet design, in which content based correspondence does not think about the gadget's physical location. It gives the productive substance's name-based correspondence functionalities for every one of the systems (e.g., work arrange, LAN, postpone tolerant system, sensor and versatile specially appointed systems).

Named Data Networking (NDN) [7] has been broadly embraced as a stage for ICN look into exercises. The crucial received in NDN is the name of required substance, not the location of hosts containing content. NDN utilizes two sorts of bundles in all interchanges: Interest and Data. A purchaser asking for a bit of substance sends an Interest parcel containing the substance name. A maker giving the relating content information restores a Data bundle to the purchaser. NDN switches exchanging the Data bundle store the parcel for future redistribution. Initially, NDN was intended for wired system topology, yet it tends to be adequately connected to remote multihop specially appointed system topology. Since hubs move around in remote specially appointed systems, the directing component is a more vital research theme contrasted and wired systems. In NDN, the motivation behind steering is the means by which to build Forwarding Information Base (FIB) for name prefixes, which indicates the correspondence between a name prefix and a face (or a neighbor identifier) to the substance with this name prefix.

NDN additionally indicates productive favorable circumstances in remote impromptu systems [8]-[9] and intellectual radio specially appointed systems [10]-[11]. Because of the communicate idea of the remote channel, the NDN-based MANETs feature extreme issues (e.g., parcel crashes, flooding, information excess, bundle retransmissions) that further corrupt the systems execution. Already, the hubs used the innetworking reserving property of the NDN that can store information bundles at any hub (i.e., leave duplicate wherever storing strategy). Subsequently, the information excess is likewise expanded in the system. In this work, developed a new protocol with location-aware on-demand fuzzy clustering based multipath caching and forwarding (LOFCMCF) designed for NDN-based MANETs. It is assumed with the purpose of each and every one the participating nodes be able to access their present location data at any time by means of some outside service such as the Global Positioning System (GPS).

2. LITERATURE REVIEW

Rhaimi et al [12] thought about Content Centric Network (CCN) as a key driver for MANET convention outline. For reproduction the CCN approach executed in ndnSIM has been utilized. Consequently, proposed to stretch out this design to assess QoS of video spilling in CCN-based MANET. Through results, research the practicality and the execution of this plan. At that point look at the advantages of proposition steering convention for CCN-based MANET with the established directing conventions in MANET. Results demonstrate that portable systems can be made more compelling and productive through CCN Network.

Alubady et al [13] have proposed two different ways: first, this examination gives an execution correlation of IP-MANET to ND-MANET as far as throughput, deferral, and bundle misfortune. While the second commitment is to recognize which engineering affects the catastrophic event in local zones and recommends which one may perform better. For trial purposes, investigations IP-MANET and ND-MANET by broad recreations in the NS3 test system under various diverse system situations, and demonstrate that how number of hubs and assortment bundles measure influence their performance.

Amadeo et al [14] displayed a data driven design for IEEE 802.11 remote specially appointed systems, named E-CHANET, which performs directing, sending and solid transport capacities, particularly custom fitted to adapt to the confinements and necessities of remote dispersed conditions. E-CHANET execution is assessed through reproductions and a correlation with the inheritance TCP/IP design and the fundamental CCN demonstrate is given. Accomplished outcomes exhibit the viability of the proposed arrangement in versatile remote conditions.

Angius et al [15] depicted BlooGo, a gossip calculation that disperses messages all through the system with a base number of trans-missions. Its quirk lies on the way that with no information of the system the recipient of a parcel can chooses self-sufficiently whether to forward it or not. All the data that BlooGo uses to choose the utility of a transmission is encased in the parcel as a blossom channel; along these lines the gatherings, i.e. sender and recipient, never need to impart specifically. This methodology makes BlooGo state-less; lightweight; control effective; perfect for sensors or implanted gadgets that utilization the NDN theory.

Amadeo et al [16] examined two classes of sending approaches: (i) a moderate, supplier daze sending technique, just went for keeping bundle excess on the communicate remote medium under control, with no learning about the area and the personality of the substance sources; and (ii) a supplier mindful procedure, which use delicate state data about the substance sources, piggybacked in Interest and Data parcels and privately kept by hubs, to encourage content recovery.

Han et al [17] exhibited an adaptive retransmission to conquer video parcel misfortunes in substance driven remote systems. As a result of in-organize reserving, the Round-Trip Time (RTT) may vary essentially. Another timeout estimation calculation is proposed to rapidly change the timeout esteem. The consecutive theory testing strategy is proposed to give hypothetical limits on the probabilities of false-positive and false-negative location rates. By thinking about the explanations behind parcel misfortunes, the plan adaptively controls its retransmission window measure. Trial results show that the proposed plot productively recoups packet losses under different system conditions.

Yu et al [18] led both reproduction and copying investigation of NDM sending plans: NDN Forwarding (NDNF), Listen-First, Broadcast-Later (LFBL), and the proposed Neighborhood-Aware Interest Forwarding (NAIF). NAIF goes for diminishing the data transfer capacity utilization actuated by aimless enthusiasm flooding in NDNF. It diminishes the intrigue activity by letting qualified transfers work agreeably, every forward just a small amount of intrigue parcels. The outcomes demonstrate that NAIF accomplishes the best execution in multi-shopper situations. Specifically, contrasted with NDNF, NAIF decreases transmission

capacity use by up to 54%, abbreviates reaction time in low-portability situations, and accomplishes high completion ratio.

Kim and Ko[19] exhibited a lightweight name-based substance recovering calculation for a multi-bounce remote CCN dependent on a three-level procedure that comprises of an intermittent forwarder data refreshing, a qualified forwarder determination, and a solid CCN message broadcasting technique strategies. Additionally have actualized the proposed plot over the CCNx testbed and led an exhaustive assessment think about, by which its unrivaled execution with over half higher throughput is demonstrated contrasted with the essential shrewd telecom strategy for CCN.

Kim et al [20] displayed a novel energy efficient content distribution scheme with the purpose of conveys the substance in a unicast way while limiting flooding overhead by exploiting ICN highlights. By means of NS-3 reproduction, think about the execution of the proposed conspire with that of other similar plans, and demonstrate that the proposed plot accomplishes substantially higher unwavering quality and vitality proficiency in substance circulation under portable impromptu system conditions.

3. PROPOSED METHODOLOGY

The proposed location-aware on-demand fuzzy clustering based multipath caching and forwarding (LOFCMCF) convention considers the areas of both a customer and a supplier amid its sending system. A transfer hub advances the Interest or Data parcel just in the event that it has less separation towards the purchaser or supplier hub, individually. The LOFCMCF protocol uses the multipath sending process that has two advantages: first, high unwavering quality is expert for transmitting both Interest and Data parcels. Second, Data bundles pursue numerous courses. Moreover, the sending procedure additionally thinks about the hub's outstanding vitality to enhance the execution of the hubs. Subsequently, content is generally disseminated over the system, which mitigates the substance recovery time for future solicitations.

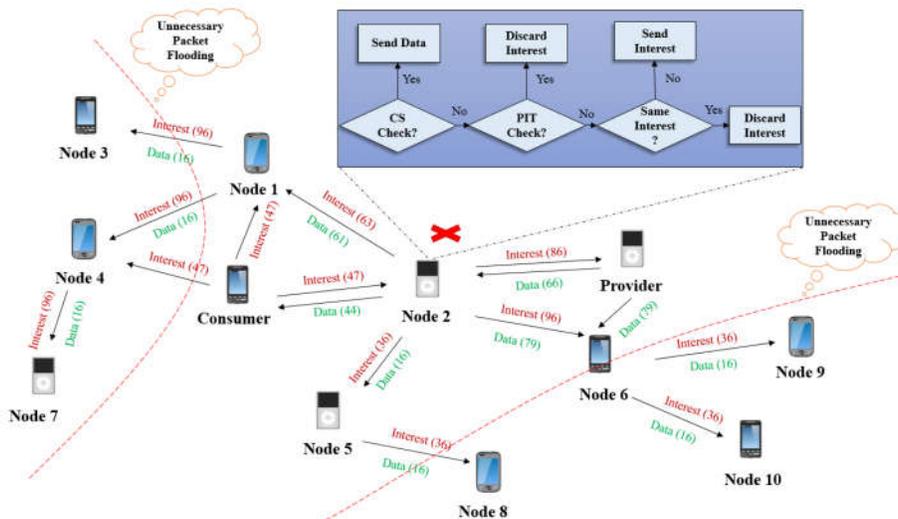


Figure 1. Problem scenario

Figure 1 outlines a precedent situation of the NDN-based MANETs, in which portable hubs can uninhibitedly move anyplace. In the event that a purchaser hub needs some substance from a supplier hub, it pursues the customary NDN correspondence strategy and communicates an Interest parcel to the supplier hub. Endless supply of the Interest parcel, transfer hub 2 checks its CS for the accessibility of a Data bundle. On the off chance that it has information, transfer hub 2 sends it back to the buyer hub. Else, it additionally checks its PIT table. In the event that there is no passage accessible, transfer hub 2 includes the Interest bundle section in the PIT table and further rebroadcasts the Interest parcel toward different hubs. Like hub 2, the other hand-off hubs (i.e., hub 1 and hub 4) receive a similar procedure of Interest bundle sending. At the point when hub 2 rebroadcasts the Interest bundle, the supplier hub and hub 5 and hub 6 likewise get a similar Interest parcel. Hubs 5 and 6 (which don't have Data bundles) additionally rebroadcast the Interest parcel to different hubs utilizing indistinguishable process from examined previously. What's more, hubs 8, 9, and 10 additionally pursue a similar sending process. Consequently, there is superfluous Interest parcel flooding in the system.

The numbers in enclosures in the figure 1 speak to the succession quantities of both Interest and Data parcels issued in the system. Endless supply of the Interest bundle, the supplier hub answers with the Data parcel. At the point when the Data bundle returns toward the customer hub, it just pursues the pending solicitations sections already put away in the PIT tables of the transfer hubs. At the point when the Data parcel is gotten by transfer hub 2, it checks its PIT table for a relating section. On the off chance that there is a passage, the hand-off hub 2 advances the Data bundle toward the purchaser hub. It likewise expels the section from the PIT table. Because of the Interest bundle flooding, the comparative demand passages are put away on numerous hubs. Endless supply of the Data parcel, the other transfer hubs (e.g., hubs 5; 6; 8; 9) additionally rebroadcast the asked for Data bundles. Subsequently, there is superfluous Data bundle flooding in the system. In any case, the correspondence is just between a shopper and a supplier hub. Flooding parcels is the hot research issue in NDN based MANETs and brings down the system execution because of superfluous bundle transmissions. In addition, in MANETs, the taking an interest hubs have constrained assets. Because of bundle flooding in NDN-based MANETs, a taking an interest hub every now and again participates in the correspondence and quickly expends its residual vitality. Thus, the hub kicks the bucket soon, which additionally debases the general system execution. In the writing, the bounce check based supplier mindful sending approaches were presented in which the hubs forward the parcels dependent on the jump remove from the supplier hub. Nonetheless, these methodologies don't perform well, particularly in high-portability cases. This is because of the way that it is difficult to support course network, particularly in unverifiable and dynamic situations. In NDN-based MANETs, every hub has the ability to store the Data parcels. Already, in a large portion of the plans, the hubs use the equivalent storing approach (LCE) that expands the information duplication in the system. For instance, in above figure 1, hubs 6; 9; and 10 superfluously store similar Data bundles despite the fact that they are close to the supplier hub.

This work proposed a LOFCMCF by fuzzy distance caching policy with the purpose of considers the Data packet duplication in the system. As per this approach, it stores Data packets close to the shopper contrasted with the supplier hub. In addition, the LOMCF convention likewise mitigates the Interest and Data parcel crashes likelihood utilizing a clock based sending process. In the LOMCF convention, a transfer hub lies into two modes dependent on its area and remaining energy. A hand-off hub is in a Potential Interest Forwarder (PIF) mode if

$$D_{cp} \leq D_{pp} \text{ and } E_r > E_{th} \quad (1)$$

where D_{pp} and D_{cp} represents the distance from a earlier relay node in the direction of a provider node and from a present relay node in the direction of a provider node, correspondingly. Fuzzy clustering, every individual is a member of simply one cluster. Presume we have K clusters and describe a position of variables $m_{i1}, m_{i2}, \dots, m_{iK}$ with the purpose of denotes the probability with the purpose of object i is categorized into group k. In fuzzy clustering, the membership is increase between each and every one clusters. The m_{ik} be able to now be among zero and one, with the condition with the purpose of the sum of their values is one. Name this a fuzzification of the cluster formation. It has the advantage with the purpose of it doesn't force each data addicted to a precise cluster Fuzzy clustering, on the other hand, determination assign a probability of regarding 0.33 for every cluster. This equal membership probability signals with the purpose of these two points are outliers. It seeks to minimize the following objective function, C, made up of cluster memberships and distances

$$C = \sum_{k=1}^K \frac{\sum_{i=1}^N \sum_{j=1}^N m_{ik}^2 m_{jk}^2 d_{ij}}{2 \sum_{j=1}^N m_{jk}^2}$$

where m_{ik} denotes the unknown membership of the data i in group k and d_{ij} is the distance among objects i and j. The memberships are liable to imperatives that they all must be non-negative and that the memberships for a solitary individual must whole to one. That is, the memberships have similar limitations that they would on the off chance those they were the probabilities that an individual has a place with each gathering. The measure of 'fluffiness' in an answer might be estimated by Dunn's segment coefficient which estimates how shut the fluffy arrangement is to the relating hard arrangement. This hard arrangement is shaped by ordering every hub into the group which has the biggest participation. The recipe for Dunn's partition coefficient is

$$F(U) = \frac{1}{N} \sum_{k=1}^K \sum_{i=1}^N m_{ik}^2$$

This coefficient ranges from 1/K to 1. Its esteem is 1/K when all memberships are equivalent to 1/K. The estimation of one outcomes when, for each question, the estimation of one membership is solidarity and the rest are zero. Dunn's partition coefficient might be standardized with the goal that it fluctuates from 0 (totally fluffy) to 1 (hard bunch). The standardized form is

$$F_c(U) = \frac{F(U) - (1/K)}{1 - (1/K)}$$

One more partition coefficient is

$$D(U) = \frac{1}{N} \sum_{k=1}^K \sum_{i=1}^N (h_{ik} - m_{ik})^2$$

This coefficient ranges from 0 (hard clusters) to 1-1/K (completely fuzzy). The normalized version of this equation is

$$D_c(U) = \frac{D(U)}{1 - (1/K)}$$

F_c(U) and D_c(U) jointly provide a good indication of an optimum number of clusters. You must decide K consequently with the purpose of F_c(U) is large and D_c(U) is small.

In Figure 1, node 2 is closer to the provider node (D_{cp}) than the consumer node (D_{pp}). Moreover, if it has higher remaining energy, then it is measured in PIF mode. E_r represents the remaining energy of the node, and E_{th} denotes the energy threshold. After experiment simulations, the range of E_{th} is set to 13% designed for computing the proposed protocol. If E_r < E_{th}, subsequently the node is measured in the Critical State. When a node is in the Critical State, it doesn't other transmit the Interest packets. As an alternative, it focuses on information packet transmissions and assures its PIT table's entries. A relay node is in a potential Data forwarder (PDF) mode and caches information packets if D_{cc} <= D_{pc} (3) where D_{cc} and D_{pc} represents the distance from a present relay node in the direction of a consumer node and from a earlier relay node to a consumer node, correspondingly. If they regard as environment is consequently dynamic in which consumer or provider node commonly changes its position then it is hard in the direction of get the precise position of the together consumer/provider nodes. In proposed LOFCMCF algorithm, every Interest and Data transmission include the latest position data of together consumer and provider node. Additionally, the proposed LOFCMCF algorithm moderates the dynamic mobility concern with by means of the multipath transmission system. In which, in cooperation Interest and information packets travel on various paths and ultimately attain in the direction of the consumer and provider node in spite of of extremely dynamic environment.

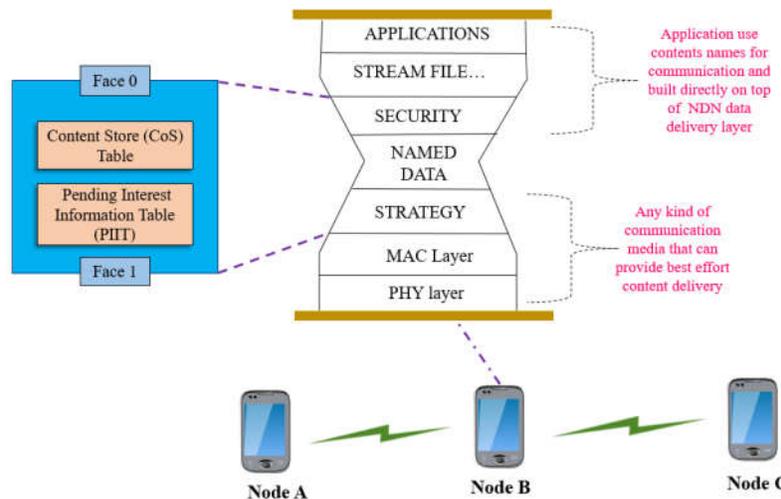


Figure 2. Node architecture in the proposed LOFCMCF protocol

A essential LOFCMCF node’s design is shown in Figure 3. In the LOFCMCF protocol, the contribute nodes in addition stop duplicate packet and collisions. When a node receives an INT-PAC or DATA-PAC, it randomly suspends and senses the channel for $T_{INT-PAC}$ or $T_{DATA-PAC}$ times, respectively. $T_{INT-PAC}$ and $T_{DATA-PAC}$ values are determined as follows.

$$T_{INT-PAC} = (T_{interval} + rand[0, T_{interval}]) * SLO_{time}$$

$$T_{DATA-PAC} = (rand[0, T_{interval} - 1]) * SLO_{time}$$

where $T_{interval}$ represents the integer value with the purpose of denotes the length of the time interval and SLO_{time} represents the fixed short time interval. Moreover, $rand()$ denotes a random function with the purpose of creates the varied random values in a predefined range. If the identical transmissions are received all through this time period, the node discards the present transmission.

2) Content Discovery Mechanism: At the point when a consumer hub requires content, it communicates an INT-PAC by including the substance name and its present position toward the neighbor hubs. At first, the consumer hub does not know the provider hub's area; it basically sets the hand-off and provider position fields of INT-PAC to its present position and invalid esteem, separately. The taking part transfer hubs just rebroadcast the INT-PAC until the point that the provider hub is come to. Endless supply of an INT-PAC, the provider hub answers with a DATA-PAC, this likewise incorporates its present area data in the consumer position field of the DATA-PAC. In addition, the supplier hub additionally incorporates the buyer area in the DATA-PAC's shopper field that is separated from the INT-PAC. In the wake of accepting the principal DATA-PAC, the consumer hub extricates the provider area data from the DATA-PAC and incorporates this data in the ensuing INT-PAC transmissions.

4. SIMULATION SETTINGS

The performance of the proposed LOMCF protocol is measured using the ndnSIM [21] simulator with the purpose is grounded on Network Simulator 3 (NS-3) version 3:19 [46]. The ndnSIM simulator is particularly considered in the direction of measure NDN-based networks. In this section, it is further extended in the direction of give maintain for multihop wireless ad hoc networks

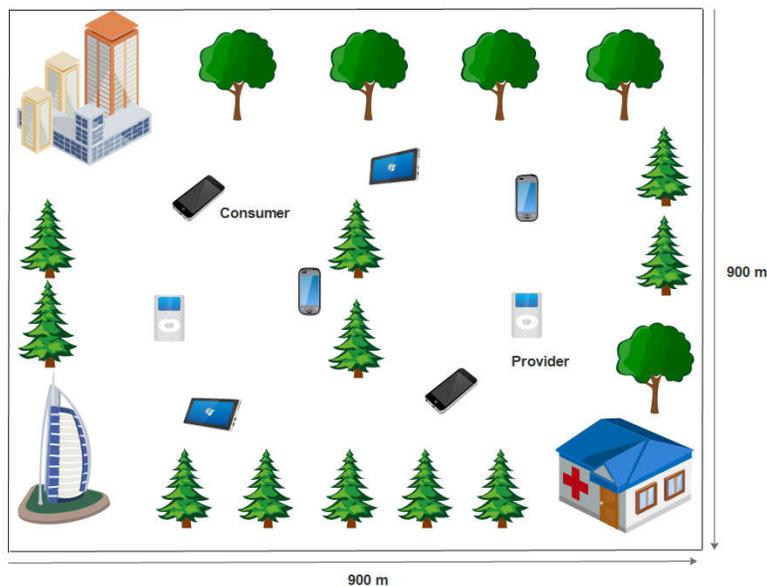
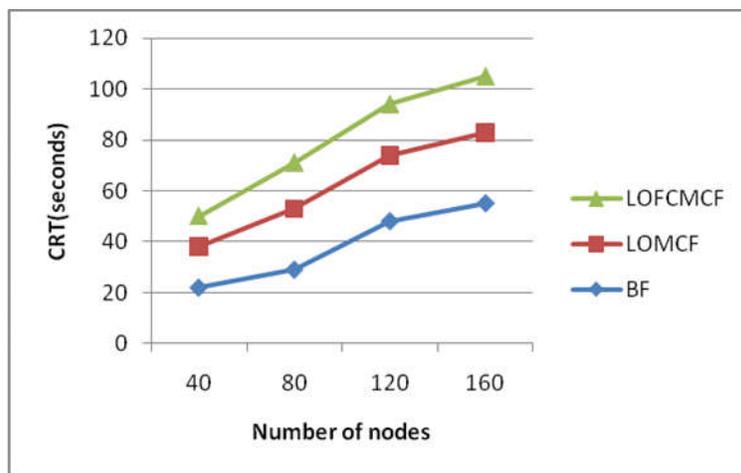


Figure 3. Random simulation topology

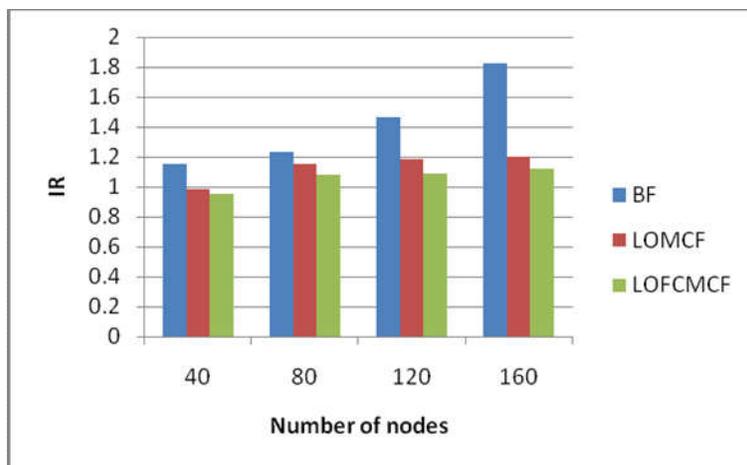
Utilize a random topology, as appeared in Figure 3, in which taking an interest hubs considering the random walk show for portability bolster. Every one of the hubs used the IEEE802.11g innovation based radio interfaces. To accomplish the multipath and shading impacts, jakes engendering model is considered amid recreation tests. The execution of the LOFCMCF convention is contrasted and as of late proposed visually impaired sending (BF) and LOMCF. Not at all like the LOMCF convention, have the two conventions used the

LCE reserving arrangement. To assess the exhibitions of every one of these conventions, have thought about the accompanying measurements.

1. Content Retrieval Time (CRT): This is described as the average time consumed with the consumer node towards retrieve each and every one the DATA-PACs of the content.
2. Interest Retransmissions (IR): This is described as the average number of INT-PACs retransmitted by means of the consumer node in the direction of download each and every one the DATA-PACs of the essential content.
3. Total Number of Interests (TNI): This is described as the total number of INT-PACs plus retransmitted INT-PACs injected by means of the consumer and relay nodes in the direction of attain the desired DATA-PACs.
4. Total number of Dropped Interests (TDI): This is described as the normal total number of INT-PACs dropped by means of the nodes appropriate to the replication of packet or lack of nodes remaining energy or a longer distance beginning the provider node.



(a)

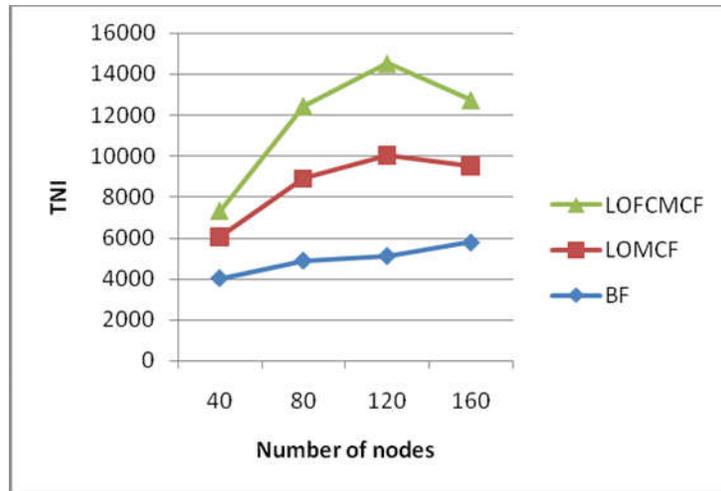


(b)

Figure 4. (a) CRT as a function of the number of nodes and (b) IR as a function of the number of nodes

The CRT metric is considered a function of the number of nodes in the network, as shown in Figure 4(a). However, the proposed LOFCMCF protocol significantly outperforms the other protocols, since proposed LOFCMCF protocol make use of the location-aware multi-route forwarding algorithm. Subsequently, the

performance degradation in the BF algorithm is more evident, as illustrated in Figure 4(b). Appropriate in the direction of node mobility, the consumer node once more requirements in the direction of trigger the INT-PACs in the direction of get their required contents. This occurrence increases the CRT in addition to IR values in the network, as illustrated in Figure 4(a) and (b).



(a)

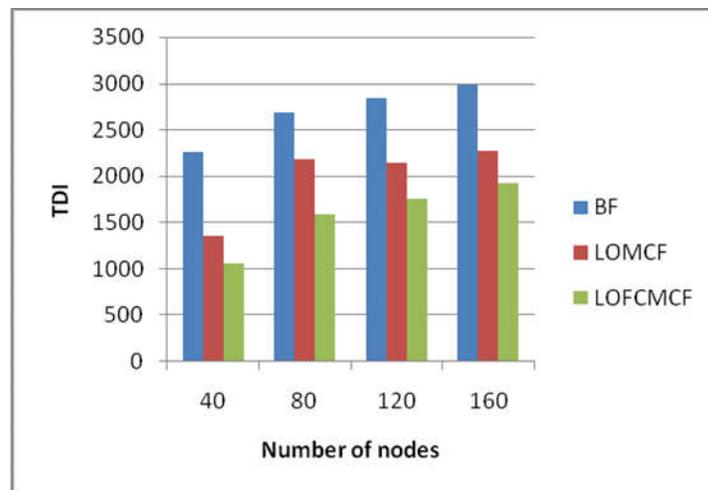


Figure 5. (a) TNI as a function of the number of nodes and (b) TDI as a function of the number of nodes

The results of the TNI and TDI metrics under the no. of nodes in the network between the proposed LOFCMCF protocol and other compared protocols are illustrated in figure 5(a-b). In Figure 5(a), in the case of 150 nodes (e.g., in Figure 5(a)), the TNI value of the LOFCMCF protocol decreases because more nodes remain in the Critical State and further prevent INT-PAC transmissions. This clearly demonstrates that, at this point (i.e., 150), the TDI value is also decreased (e.g., in Figure 5(b)).

5. CONCLUSION AND FUTURE WORK

In this work, developed a new protocol with location-aware on-demand fuzzy clustering based multipath caching and forwarding (LOFCMCF) designed for NDN-based MANETs. It is assumed with the purpose of each and every one the participating nodes be able to access their present location data at any time by means of some outside service such as the Global Positioning System (GPS). The proposed LOFCMCF protocol go after the multipath forwarding system with the purpose of moderate the content retrieval time in addition to increases the dependability of together Interest and Data packets. It develops the fuzzy distance-based caching policy with the purpose of decreases the information packets duplication in the network. The proposed LOFCMCF protocol increases the networks performance with taking into consideration the node’s remaining energy in its packet-

forwarding machine. Future work, LOFCMCF protocol obtains the remaining energy of the node addicted to account with the purpose of increases the node in addition to network performance.

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