

Applying Clustering Approach to Mobile Content-Centric Networking (CCN) Environment

Muhammad Saad*, Seungoh Choi*, and Byeong-hee Roh*

*Department of Computer Engineering, Graduate School of Ajou University, Suwon, Korea

e-mail : {muhammadsaad, uwer1, bhroh}@ajou.ac.kr

Abstract

Considering the recent few years, the usage of mobile content has increased rapidly. This brings out the need for the new internet paradigm. Content-Centric Networking (CCN) caters this need as the future internet paradigm. However, so far, the issue of mobility in the network using CCN has not been considered very efficiently. In this paper, we propose clustering in the network. We apply clustered approach to CCN for catering the mobility of client node in the network. Through this approach we achieve better convergence time and control overhead in contrast to the basic CCN.

1. Introduction

Due to the increase in the number of mobile devices, the usage of mobile content has also increased. The increase in mobile content being hosted by media servers and web portals require the establishment of un-interrupted end-to-end connection of servers with the devices for the retrieval of contents. The current Internet architecture have a lot of issues relating to the content exchange especially when it comes to the case of mobile and wireless devices [1][4]. Considering these factors, new networking technology has been proposed, called the content based networking, where the content queries and data are routed based on the content name [2].

Currently, researchers are working to explore new horizons of Content-Centric Networking (CCN) in mobile environment. The work done includes the proxy-based mobility management scheme [1]. In this scheme, a fixed physical proxy is configured as an overlay architecture over IP networks. Another scheme is the flow mobility [3], which also uses a physical mapping agent and devices with multiple interfaces. However, both increase the equipment cost. The goal of this paper is to present a scheme which provides a better download time of the content and low control overhead over the network when the client mobile node is moving. The proposed Clustered based approach is applied to mobile CCN environment without additional equipment and keeping CCN rules intact.

2. Problem Statement

The Client Node (CN) is the mobile device node which sends an Interest packet. This Interest packet is routed to the Source Node (SN) having the content through the longest prefix matching through the Forward Information Base (FIB) and the Interest is relayed back to the CN through the reverse path. As the CN moves from original location, it has to send Interest again from the new location which causes long delay in data retrieval and thus brings out the in-efficiency of the CCN in mobile environment. To solve this issue, this paper presents the Cluster based approach applied to mobile CCN environment which works on the same CCN architecture of pull mechanism.

3. Proposed Scheme

The proposed scheme works in two parts namely, *cluster formation* and *node movement*.

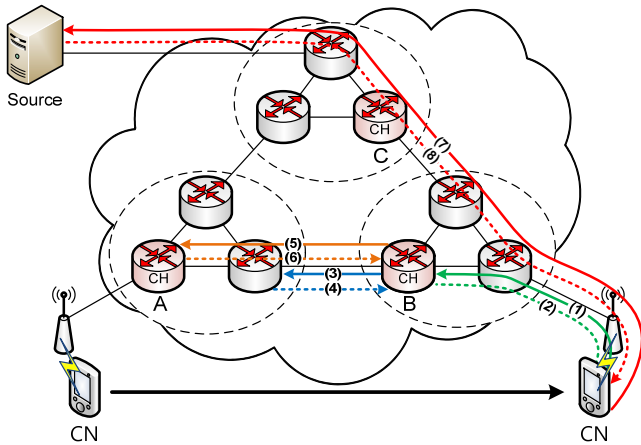
A. Cluster formation

As this scheme works on the clustering approach, the first step is the formation of clusters. Since CCN does not use IP addresses and works on the pull mechanism, the clusters formation also takes place through pull mechanism abiding by the CCN rules. All the routers send *inform* Interest to other routers connected through their faces. The routers receiving the *inform* Interest reply with their available memory. On reception of the reply, every router checks the available memory with other routers and forms a cluster joining the highest available memory router. Since the cluster head (CH) has to maintain the information of its cluster members and also the CN connected to the cluster, therefore, highest available memory router becomes the CH. We make an assumption here that all the CHs are manually named. The cluster members send *name* Interest to the CH asking about the CH name and CH replies with its name.

B. Node Movement

When the clusters are formed, the CN is connected to one of the formed clusters. The CN sends periodic Hello Interest to the CH asking its name and the face on which the serving router is connected. The Hello packet reply may result in three possibilities, (i) the CH name and the serving router face are same as the CN has, (ii) the CH name is the same but the face to the serving router is different, and (iii) both the CH name and the serving router face are different. While the data is being relayed and the CN moves, the CH on not receiving the periodic *Hello* Interest from CN holds the data which indicates that the node has moved.

In this paper, we focus on the *third* possibility. In the first two possibilities, the CN remains in the same cluster. First possibility indicates no CN movement while there is intra-cluster movement in second possibility which is resolved by updating the face of serving router. Fig. 1 shows the working of the proposed approach for third possibility which indicates the CN movement and the new path formation.



(Figure 1) Proposed scheme scenario

Since CCN works on two types of messages: *Interest* and *Data* packets, therefore, all the request messages indicate *Interest* while all the replies indicate *Data*.

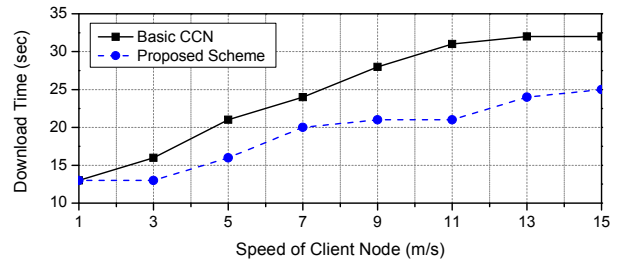
CN will send *ConnReq* (Connection Request) Interest to the new CH along with the name of the old CH and the last Interest packet sent for the requested content (1). The new CH sends *ConnConf* (Connection Confirm) message to the CN (2), and send *Border Interest* to the cluster border routers (3). The *Border Interest* query asks the routers about their CH names. The Cluster border routers reply giving the CH name (4). The new CH matches the name of the border CHs with the name of the old CH received from the CN. On getting a match, the new CH sends *UpRoute* (Update Route) Interest to the old CH (5). The Old CH after updating the route replies with *UpRouteConf* (Update Route Confirm) message to the new CH forming a redirection (6). The new CH send *UpPath* (Update Path) Interest to the cluster member routers based on the last Interest packet sent by CN at old location (7). Cluster member routers update the path to the source and send *UpPathConf* (Update Path Confirm) message to the new CH after which the redirection no more exists and a new path is formed (8).

4. Performance Evaluation

To show the effectiveness of our proposed scheme, we obtained two results through our simulation environment involving 16 routers connected in 4 clusters, packet size of 4KB, and wireless router capacity of 10Mbps while the response time is kept random. The mobile device is moved among all four clusters in 360 degrees with the varying speed so that the results can be accurately evaluated. The proposed scheme performs better than the basic CCN in both the obtained results which shows the effectiveness of this scheme.

A. Download time of content

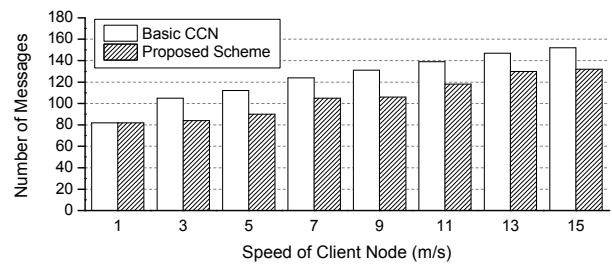
Fig. 2 shows the comparison of the proposed scheme with the basic CCN for the download time of content. A sudden delay in the proposed scheme is due to inter-cluster movement of the CN which are experienced after every certain distance the node travels as every cluster has its own range depending upon the range of the routers involved in the cluster.



(Figure 2) Download time of content

B. Control overhead of overall network

Fig. 3 shows the number of messages required as the CN starts moving. Due to inter-cluster movements, the proposed scheme shows sudden increase in the graph.



(Figure 3) Control overhead of overall network

5. Conclusion

Mobile CCN environment deals with the CN movement issues which opened new gateway for the researchers to come up with new schemes. In this paper, we proposed cluster-based approach to CCN where no additional hardware is used to store information and the CCN routers themselves maintain the CN movement. This scheme gives better performance than basic CCN for both the download time of content and the network control overhead.

Acknowledgement

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References

- [1] J. Lee, D. Kim, M. Jang, and B. Lee, "Proxy-based mobility management scheme in mobile content centric networking (CCN) environment," *ICCE 2011*, pp. 595-596, Jan. 2011.
- [2] J. Lee, D. Kim, M. Jang, and B. Lee, "Mobility management for mobile consumer devices in content centric networking (CCN)," *ICCE 2012*, pp. 502-503, Jan. 2012.
- [3] H. Rim and S. Hong, "A seamless content delivery scheme for flow mobility in content centric network," *APNOMS 2012*, pp. 1-5, Sep. 2012.
- [4] S. Oh, D. Lau, and M. Gerla, "Content centric networking in tactical and emergency MANETs," *IFIP 2010*, pp.1-5, Oct 2010.