A Seamless Content Delivery Scheme for Flow Mobility in Content Centric Network

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Abstract—**Recently smart devices include various interfaces to communicate using 3G, LTE, WiFi and Bluetooth. Additionally a research, named flow mobility, which maintains seamless communication session has progressed using different interfaces in the smart device. Content Centric Network which is one of the Future Internet research issues is studied to solve a problem which is occurred by node mobility. In this paper we propose an efficient and seamless content delivery scheme using flow mobility in CCN. To solve mobility problem in CCN, we introduce a mobility scenario with proposed scheme.**

Keywords-Content Centric Network, Content Delivery, Flow Mobility

I. INTRODUCTION

Recently various smart devices in the market have different interfaces to communicate with 3G, LTE, WiFi and Bluetooth. Many researchers have started to study to provide services via various interfaces. Video streaming services and music streaming services like youtube, afreeca, melon and itunes are popular in these days. Also flow mobility is an active and vibrant research to maintain a recent communication session with different interfaces at the smart devices which is included in various interfaces. Specifically it is a popular research to adapt flow mobility on PMIPv6 Network [1][2].

To discard inefficient data transmission in the current Internet, many researchers started studying of a way which does not use IP addresses in the current Internet but uses data name for data communication in the network. Among these researches, Content Centric Network (CCN) is one of the content based networks for future Internet [3, 4, 5].

However, in CCN when node moves to another CCN router during data delivery, it causes a problem which increases the number of messages in the network. And users are not provided with seamless services at that time. As a reason, mobility support scheme is necessary to solve this problem. In this paper, to solve a node mobility problem during data delivery, we propose an efficient and seamless content delivery scheme using flow mobility in CCN. Also to maintain session, we proposed Flow Mapping Agent. Using our proposed scheme, we can solve a problem with node mobility scenario.

The remainder of this paper is organized as follows. In section II, we briefly introduce about flow mobility and CCN. Then we discuss about the problem statement of content delivery in CCN. Section III introduces our proposed scheme using flow mobility for efficient and seamless delivery in CCN. For the verification of our scheme, we present the evaluated result in section IV and we explain the conclusion and our next step in section V.

II. RELATED WORKS

A. Flow Mobility

Recently, as smart devices are equipped with one or more interfaces, techniques are needed to use these interfaces at the same time. Researchers try to study to maintain communication using various interfaces simultaneously. Flow mobility is the one of the researches. In these days, researches of flow mobility are focused on PMIPv6.

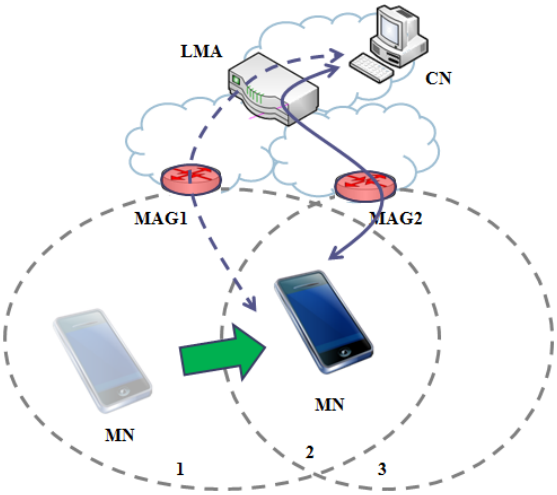

Figure 1. Flow Mobility in PMIPv6

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Flow Mobility in PMIPv6 minimizes the number of messages at the smart devices. And this scheme means a technique that transfers present IP session to other interfaces to maintain IP session. At present, research of flow mobility is proceeding actively at netext working group of IETF.

B. *Content-Centric Network*

Recently, many researchers have tried to keep current Internet architecture and replace some functional parts to improve the current Internet in the network. However this improvement did not solve real problem of current Internet. As a result, Future Internet researchers start to study the clean slate approach. Content-Centric Network (CCN) is one part of Future Internet research which concerns with sharing data [6, 7, 8].

Figure 2 shows a basic routing scheme [9] for content centric network. A basic routing scheme in CCN is described in the following sequences:

(1) The client 1 requests content to CCN router H. When CCN router H receives client 1's interesting packet, it checks its content cache table to find the requested content is in the table or not. If requested content is found within cache table, CCN router H sends the requested content to client 1. However if content is not in cache table, CCN Router H sends an interesting packet to other CCN routers. In this way, interesting packet is sent to the CCN Router A which has the requested content.

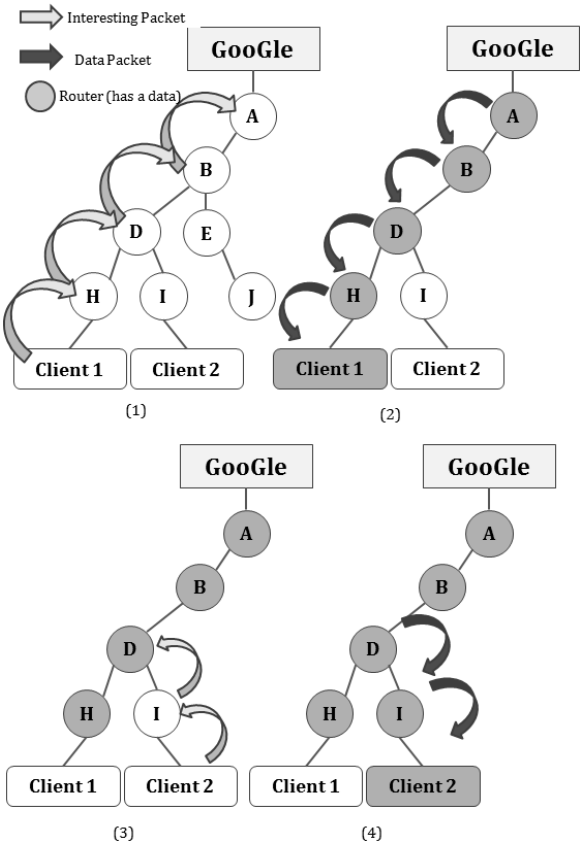

Figure 2. Basic Routing Scheme for CCN

(2) CCN router A receives an interesting packet from CCN router B and checks its cache table. Then CCN router A sends the requested content using reverse path to router H and when each CCN router receives contents, it stores the contents into content cache. Finally, client 1 receives the requested content from CCN router H.

(3) The client 2 requests same content which is requested by client 1. CCN router I receives an interesting packet. However CCN router I doesn't have the requested content in its cache table. In this case, client 2's request message is sent to node D.

(4) When node D receives the interesting packet, it sends a data packet including requested content to client 2.

C. *Problem Statement*

We introduced what is CCN basic routing scheme in section B. CCN routing scheme sends data packet using reverse path to the sender. That is why this scheme creates some problems in the network. When a CCN node moves to another CCN router, previous CCN router cannot know the destination of data packet. And CCN node tries to send interesting packet to receive the requested content again. It can lead to increase in the number of messages in network. And this can increase network overhead. Moreover, user cannot be served the streaming services while the node finishes retransmission of the content.

Figure 3 shows a problem when node is moved to other CCN router during data transmission. As mentioned earlier, ① CCN node is moved to another CCN router. ② CCN router (a) cannot transmit the data packet as CCN router (a) doesn't know the destination of the data packet. ③ After finishing move, CCN node tries to send the interesting packet to the present

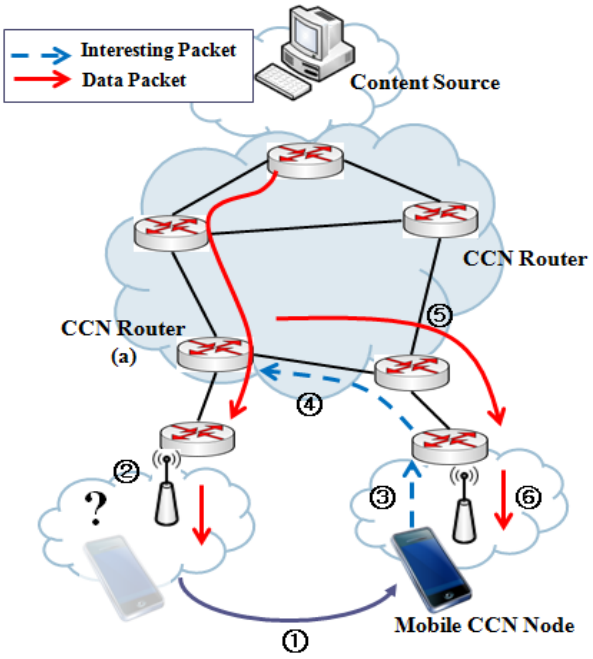

Figure 3. Problem of Node Mobility

CCN router to receive remaining content. ④ a router which has received interesting packet from the CCN node checks its content cache. ⑤ if there is no content in the cache table, router sends interesting packet using same way explained section B. ⑥ If a CCN router which has the requested content in its content cache similar to the CCN router (a), it sends data packet to CCN node again. However if an interesting packet is not delivered to CCN router including the requested content, router send interesting packets until finding the CCN router which has a content. As that reason, new technique is necessary to reduce the overhead in the network.

III. PROPOSED SCHEME

In this paper, we try to solve problems caused by CCN routing scheme and node mobility. We perform efficient and seamless content delivery scheme using flow mobility. First we assume our CCN nodes have multiple interfaces for communication. And CCN nodes can connect with CCN router using a different interface. Also we proposed Flow Mapping Agent (FMA) to maintain the flow in the network. And FMA can connect CCN routers directly.

A. The Architecture of Supporting flow mobility in CCN

Figure 4 shows the architecture of the proposed content delivery scheme. We proposed FMA to maintain seamless content delivery. Basic routing operation uses the same method introduced in previous section. Additionally when CCN node connects with CCN router, CCN router sends information containing node ID and interface ID to FMA. FMA registers information from CCN router in the Flow Mapping Table (FMT). Table 1 shows FMT in FMA.

B. Operation for Seamless Content Delivery

CCN node tries to connect with the new router using other interfaces if CCN node can connect with new router. In figure 4, when CCN node moves to area 2, CCN node can connect with CCN router 2 using another interface even while CCN node is communicating with CCN router 1. After connecting with CCN router 2, CCN router transmits CCN node information to FMA. FMA registers connection information

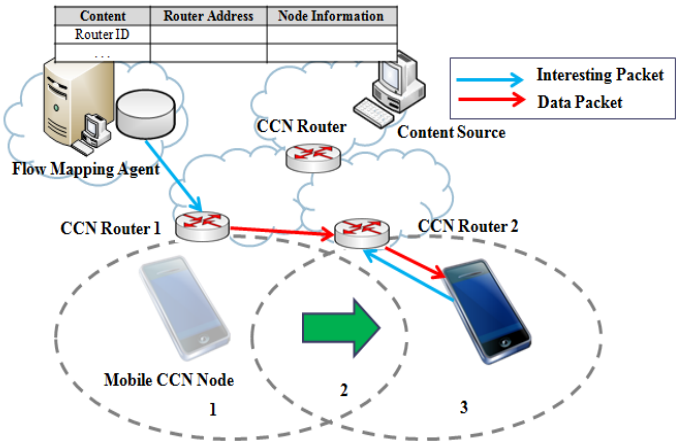

Figure 4. Architecture of CCN using flow mobility

TABLE I. FLOW MAPPING TABLE

Content	Router Address	Node Information
Router ID		
. . .		

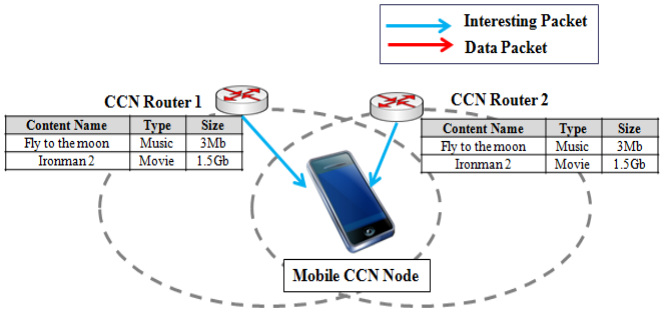

Figure 5. Efficient Content Delivery Scheme

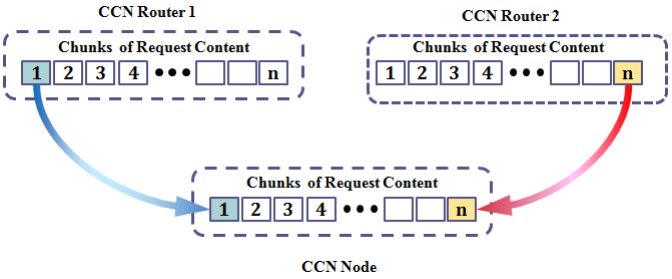

Figure 6. Bi-Directinal Content Delivery using the last number of chunk

from CCN router 2. After the registration of CCN node, FMA checks its FMT table using Node ID. If Node ID exists in FMT table, FMA considers CCN node is moved to CCN router 2. Then FMA sends interesting packet to CCN router 1 to deliver data packet to CCN router 2. When CCN node is moved to area 3, CCN node can receive data packet from CCN router 2 via the interface connected toCCN router 2.

C. Operation for Efficient Content Delivery

As several interfaces can communicate with each other in CCN node, we consider efficient content delivery using Bi-directional content delivery scheme. In figure 5, mobile CCN node connects with CCN router 1 using interface 1 and CCN router 2 using interface 2. If CCN node receives contents from CCN router 1 via interface 1, interface 1 sends interesting packet to interface 2 in CCN node. After receiving interesting packet, CCN node tries to transmit interesting packet to CCN router 2 to find content. If the CCN router 2 has a requested content, CCN router 2 sends data packet using reverse way from the last number of chunks. Figure 6 shows the bi-directional content delivery. It can help to reduce the download time at CCN node.

However, if the user has used streaming service and content size is very huge, bi-directional content delivery using the last number of chunk doesn't guarantee the QoS. In the figure 5, suppose the user wants to watch the movie via CCN node and he stays in the area 2. Mobile CCN node can connect with CCN router 1 using interface 1 and CCN router 2 using

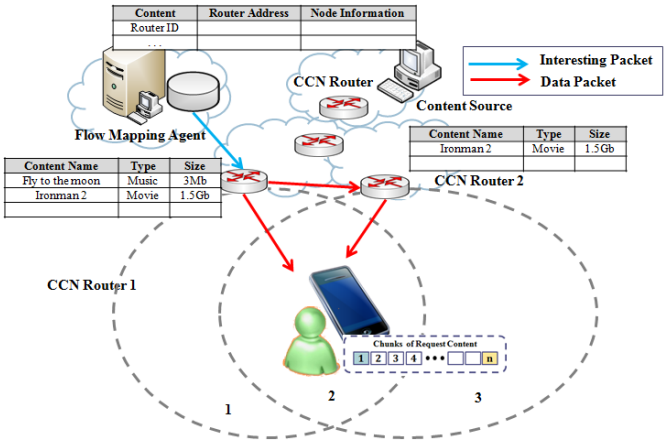

Figure 7. Scenario of Proposed Scheme

interface 2. As described earlier, CCN node starts to receive the Movie content from CCN router 1. And Interface 1 gives interesting packet to interface 2. Interface 2 sends an interesting packet to CCN router 2. CCN router 2 receives interesting packet and checks its content management table whether the requested content is existed or not. As request content is found in the content management table, CCN router 2 transmits data packet to CCN node using the last number of chunks. if the connection between CCN node and CCN router 1 are broken, streaming service is delayed because CCN router 2 doesn't have sequential chunks. Therefore, when the user uses streaming service, it is better to use sequential sending.

D. A Scenario of Efficient and seamless Content Deleivery

In this paper, we introduce the efficient and seamless content delivery scheme using flow mobility in CCN. Figure 7 shows the scenario of proposed content delivery Scheme which is as the follows :

1. When user wants to download music content using an application in the mobile CCN node. CCN node tries to connect with CCN router 1.
2. After connection with CCN router 1 using interface 1, CCN router 1 sends information of CCN node to FMA for registration. And CCN router sends request content to CCN node.
3. FMA registers information of CCN node from CCN router 1.
4. CCN node moves to area 2. And it finds a new router for the connection. CCN node tries to connect with CCN router 2 via interface 2.
5. CCN router 2 sends information of the CCN node to FMA after the connection.
6. FMA registers information and it looks up its FMT. Then FMA finds CCN node which connect with CCN router 1 using interface 1.
7. FMA considers CCN node has moved to the CCN router 2. As CCN router 2 already has the requested content, CCN router 2 sends a data packet to CCN node via interface 2 with the last number of chunks.

If user wants to use movie streaming service, Scenario is as follows :

1. As described earlier, repeat Progress is same from 1-6.
2. FMA considers CCN node has moved to the CCN router 2. FMA sends interesting packet to CCN router 1 to transmit data packet to CCN router 2.
3. CCN router 1 sends the data packet to CCN router 2.
4. After receiving the data packet, CCN router 2 sends content to CCN node with interface 2.

IV. PERFORMANCE EVALUATION

In this paper, we have introduced our proposed scheme which is efficient and seamless content delivery scheme using flow mobility in CCN. To evaluate the performance of our scheme we have performed simulation using Java. We set router to send information of the node to FMA when the node is moved and connected with new router. We deployed CCN node as in figure 7 and compared our proposed scheme with original CCN. Table II represents evaluation environment.

Figure 8 shows a comparison between the increase in the number of message after node has moved. As we already explained above, our proposal needs just two messages of one interesting packet and one data packet. However in the basic CCN, if it can find the router containing requested content, it would cost double the number of hops. The worst case scenario is that interesting packet will visit all CCN router in figure 7.

TABLE II. ENVIRONMENT OF EVALUATION

Parameter	Value
Total Number of Nodes	4
The Number of Contents	2
The Size of Contents	5Mb, 100Mb
Total Number of Simulation	100
Used Tools	Java

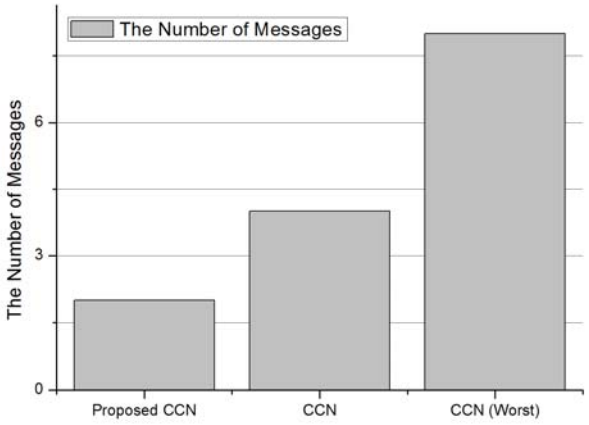

Figure 8. Comparison of hte the Number of Messages between Proposed scheme and basic CCN

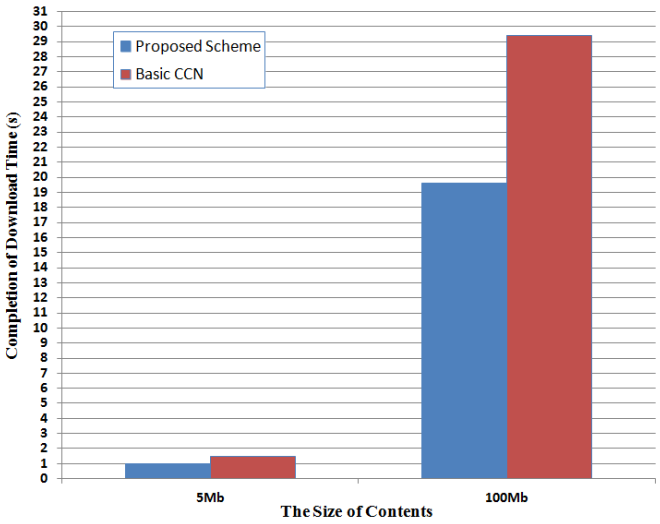

Figure 9. Comparing Completion of Download Time between Proposed Scheme and basic CCN

As shown in Figure 9, we have compared the completion time of content download between our proposed scheme and basic CCN. Before our simulation, we expected that our proposed scheme will perform at most twice the completion time of regular CCN, because our Scheme uses two routers. However the results show more shortage performance than our expectation. The possible cause of this simulation result may be caused by physical problems such as network status and memory storage performance.

V. CONCLUSION AND FUTURE WORKS

In this paper, we try to solve the node mobility problem during data delivery. So we proposed an efficient and seamless content delivery scheme using flow mobility in CCN. For seamless content delivery, we proposed Flow Mobility Agent(FMA). FMA manages information of connections between CCN routers and CCN nodes. FMA also manages data flows using checking CCN node ID and information of interfaces connected CCN router. If same CCN node Id is found in FMT but its interface is different, FMA considers CCN node has moved to a new CCN router. And FMA sends an interesting packet to delivery request content to the new CCN router. After completion of moving, CCN node just sends interesting packet to new CCN router. For efficient content delivery, we proposed a bi-directional content delivery scheme using the last number of chunks. However we found that if user wants to use an application for streaming services, our delivery scheme which uses the last number of chunks does not guarantee QoS. So in near future, we will try to solve this problem. We also show the scenario of efficient and seamless content delivery. We perform simulation using this scenario to evaluate our scheme. We compare our proposal with basic CCN scheme. And we show our proposed scheme has a better performance.

As described earlier, our content delivery scheme using the last number of chunks doesn't guarantee QoS at the streaming service which uses large amount of data. For solving this problem, we need to study further. To make good evaluation, we would have a comparison between our scheme with another scheme for streaming services.

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