Supporting ICN in 5G Core Network

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***Abstract*— ICN effectively delivers content, such as multimedia and IoT, by name-based routing. Recently, works on supporting ICN in 5G network have been actively studied for effective data delivery in 5G. However, they mainly focus on interworking network architecture and extended NF and interface to support ICN, and little works have been carried out for a detailed procedure supporting ICN in 5G network, to the best of our knowledge. In this paper, we propose content name registration, ICN PDU session establishment, and *Interest*/*Data* packet delivery procedures to support ICN in an extended 5G core network.**

Keywords—5G, ICN

I. Introduction

Information-centric networking (ICN) effectively delivers content, such as multimedia and Internet of things (IoT) by content name-based routing. A consumer requesting a content sends an *Interest* packet including the content name, and a producer or an intermediate ICN router caching the content corresponding to the requested content name returns *Data* packet including the content to the consumer [1],[2]. An ICN router has pending interest table (PIT), forwarding information base (FIB) and content store (CS). PIT records the information of the incoming face of the received *Interest* packet. FIB is a table used to forward *Interest* packets to appropriate faces towards the router that caches the requested content. CS caches the received content [1], [2].

Recently, ICN is regarded as an important technology that effectively provides efficient mobility of consumers and producers, content delivery, and communication in 5G network [3], and works on supporting ICN in 5G network have been actively carried out [4], [5]. The mutual benefits of integration between ICN and multi-access edge computing (MEC) are analyzed, and 5G MEC structure is designed to provide ICN in 5G MEC environment [4]. In ITU-T SG 13, based on IMT-2020, network functions (NFs) with ICN functions and edge-based NFs that support ICN NFs are newly designed in ICN-enabled edge networks [5]. The Internet research task force (IRTF) information-centric networking research group (ICNRG) proposed interworking 5G network with ICN by extending current NFs or newly proposing NFs [6]-[8]. Also, transport convergence layer (TCL), which is located between the application layer and the transport layer, is proposed to provide both IP and ICN traffic in 5G UE effectively [9].

In the mentioned works on interworking 5G network with ICN [4]-[8], however, they mainly focus on interworking network architecture and extended NF and interface to support ICN, and little works have been carried out for a detailed procedure supporting ICN in 5G core network, to the best of our knowledge. In this paper, we propose contents name registration, ICN PDU session establishment, and *Interest*/*Data* packet delivery procedures to support ICN in an extended 5G core network.

In Section II, procedures for ICN support in 5G core network are proposed. Summary and future works are presented in Section III.

II. Procedures For ICN Support In 5G Core Network

In this section, considered architecture and proposed procedures are basically based on the 3GPP architecture [10] and procedure [11] for 5G. Also, an overlay model proposed in [6] is applied for extended 5G network architecture to support ICN, where ICN is deployed over IP between user equipment (UE) and ICN gateway (GW).

Figure 1 shows considered extended 5G network architecture interworked with ICN, which is adopted from the work in [6]-[8]. ICN service/network controller interacts with ICN application function (AF) and ICN data network (DN) to register application service for ICN contents. ICN AF provides ICN related information to NFs in the 5G core network and manages content names. Access and mobility management function++ (AMF++) is an extended version of AMF, and processes ICN request of UE and interacts with session management function++ (SMF++). SMF++ is an extended version of SMF for ICN protocol data unit (PDU) session establishment and content information request. SMF++ is used to manage ICN PDU sessions between UE and ICN DN, and interacts with AMF++ and ICN AF. Network exposure function (NEF) requests content information through the interaction with SMF++ and ICN AF when establishing an ICN PDU session. The policy control function (PCF) and unified data management (UDM) interact with the ICN AF to select an ICN service slice or provide PDU session requirements.

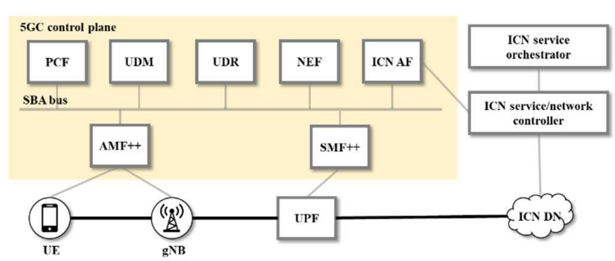

Fig. 1. An extended 5G network architecture interworked with ICN.

A. Content Name Registration

Figure 2 shows the procedure of registering contents generated by contents producer located in the ICN DN to the 5G core network. The content information generated by the producer is registered in the ICN DN and the 5G core network

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through the *content name prefix registration procedure* in ICN DN and the *ICN application registration procedure* in 5G. In the *content name prefix registration procedure* in ICN DN, when a content producer creates and registers content, *FIB update* packets including the content name prefix are spread to ICN routers in the ICN DN. ICN routers that receive the *FIB update* packet record the content name prefix in their FIBs. In the *ICN application registration procedure* in 5G, the ICN GW, which is an ICN router that interacts with 5G, requests content name prefix registration to the ICN service/network controller. The ICN service/network controller generates ICN application configuration information including the data network name (DNN), ICN GW IP address, and received content name prefix, and sends the *ICN application configuration information* to the ICN AF. ICN AF stores the received ICN application configuration information.

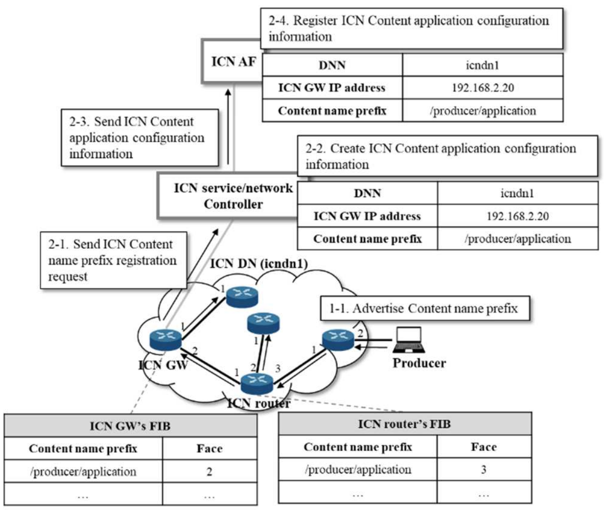

Fig. 2. Content name registration procedure.

B. ICN PDU Session Establishment

Figure 3 shows the procedure of an ICN PDU session establishment. When requesting ICN-based content, the UE creates a non access stratum (NAS) message, *ICN PDU session establishment request*, including the content name prefix, and sends it to AMF++ to initiate an ICN PDU session establishment request. AMF++ selects the SMF++ that manage the ICN PDU session, and sends the context message, *ICN PDU session creation/update SM context request*, including the content name prefix to the selected SMF++. SMF++ requests ICN DN information by sending the received content name prefix to ICN AF through NEF. ICN AF, which receives the content name prefix, sends the *ICN application configuration information* to SMF++ through the NEF. SMF++ selects a UPF based on the received *ICN application configuration information* and allocates the IP address of the UPF by sending an *N4 session establishment request message* to the selected UPF. In addition, SMF++ sends ICN PDU session information including the UE's IP address and ICN GW IP address to the UE through AMF++. When the ICN PDU session establishment procedure requested by the UE is completed, a new ICN PDU session is established between the UE and the ICN GW.

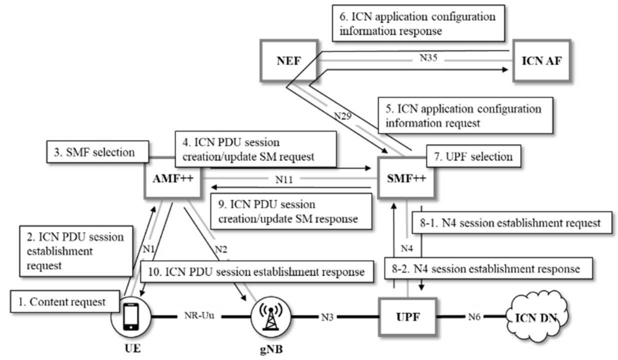

Fig. 3. ICN PDU session establishment procedure.

C. Interest Packet Forwarding

Figure 4 shows the procedure of the *Interest* packet forwarding. When UE generates *Interest* packet, it sends an IP packet with the *Interest* packet as a payload to gNB, where the source and destination addresses are set to the UE's IP address and the ICN GW's IP address, respectively. Then, the gNB encapsulate the received packet via GTP and sends it to the UPF. UPF decapsulates the received packet and sends IP packet with the *Interest* packet as a payload to ICN GW. ICN GW extracts the *Interest* packet and stores the IP addresses of the related UE and UPF. Then, the ICN GW forwards the *Interest* packet to an appropriate face based on the information of FIB. The ICN router in ICN DN, which receives the *Interest* packet, records the content name and incoming face in the PIT. The *Interest* packet is finally delivered to either producer or intermediate ICN router which caches the requested content.

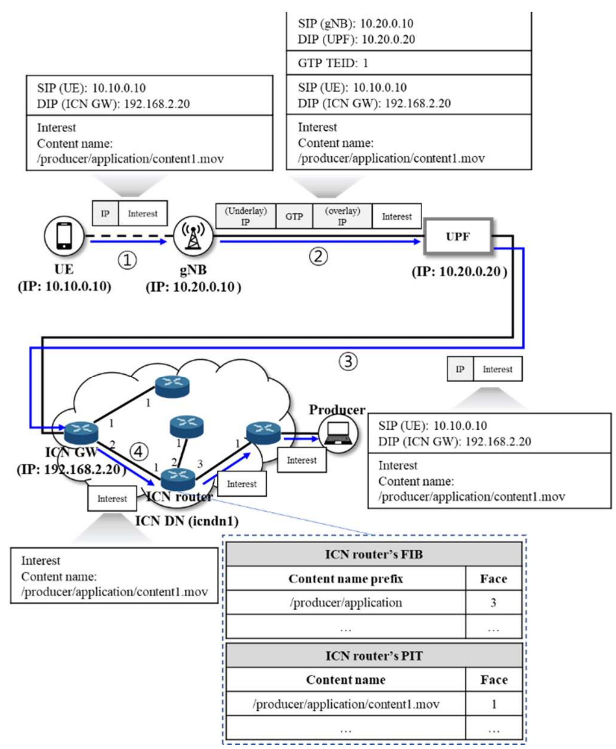

Fig. 4. *Interest* packet forwarding procedure.

Figure 5 shows the procedure of delivering *Data* packets from either producer or intermediate ICN caching router in ICN DN to the requesting UE. The producer or intermediate ICN caching router that receives the *Interest* packet returns *Data* packet to the ICN GW, based on ICN routing. When the ICN GW receives the *Data* packet, it sends IP packet with the *Data* packet as a payload to the UPF corresponding to the requested content. The UPF encapsulate the received IP packet via GTP and sends it to the gNB connected to the requested UE. The gNB decapsulate the received packet and sends IP packet including the *Data* packet to the UE.

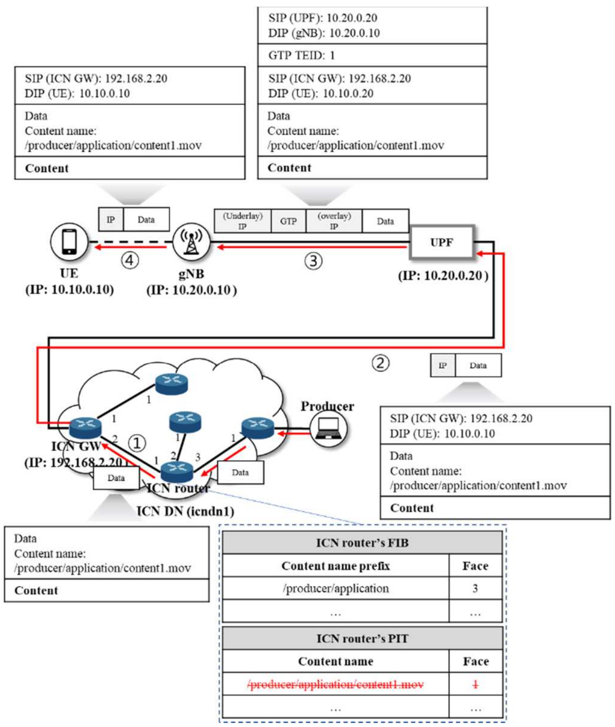

Fig. 5. *Data* packet forwarding procedure.

III. SUMMURY AND FUTURE WORKS

In this paper, we proposed a detailed contents name registration, ICN PDU session establishment, *Interest*/*Data* delivery procedures to support ICN service in an extended 5G core network. The proposed procedures will be validated in 5G open source testbed in our future work.

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