CCNx Extension for Name Resolution Service
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Abstract

This document presents the CCNx extension for Name Resolution Service (NRS). It describes TLV-based CCNx messages for NRS and modification of CCNx forwarder where the messages for NRS are working.

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1. Introduction

In Information Centric Networking (ICN) [RFC7927], the name resolution is defined as the first step of ICN routing along with content discovery and delivery, which translates a content name to locator(s) of providers/sources that can provide the content. However, the name resolution step can be omitted in the hierarchical name based routing.

NDN [NDN] and CCN [CCN] are representative projects of ICN which use the hierarchical name based routing. Nevertheless, in [Afanasyev], in order to address the routing scalability problem in NDN’s DFZ, a distributed mapping system called NDNS was designed, which maintains and lookups the mapping information from a name to its globally routed prefixes. Here, NDNS is a kind of Name Resolution Service (NRS) in NDN.

Similarly, CCN also has a challenge to address the routing scalability problem in CCN’s DFZ even though CCN uses the hierarchical name based routing. Thus, NRS can be utilized in CCN for the scalable name based routing as well as the efficient mobility support.

This document presents the design of NRS-Mapping System (NRS-MS) which is a system that provides the name resolution service in CCN and its implementation by extending CCNx. It also describes TLV-
based CCNx messages for NRS and modification of CCNx forwarder where the messages for NRS are working.

2. Conventions and Terminology

The key words "MUST", "MUST NOT", "REQUIRED", "SHALL", "SHALL NOT", "SHOULD", "SHOULD NOT", "RECOMMENDED", "MAY", and "OPTIONAL" in this document are to be interpreted as described in [RFC2119].

This document uses the terminology of [CCNxSemantics] and [CCNxMessages] for CCNx entities.

The following terms are used in this document and defined as follows:

- Mapping Server (MS) : stores and maintains the actual mapping table which keeps the bindings of name to some information that is used for forwarding Interest. MS is a role of NRS resolver and all NRS messages are processed through the MS. In other words, CCN nodes such as consumer, provider communicate with only MS to get the name resolution service. Thus we design the MS using CCN protocol assuming that the NRS is served at the content router (CR) and each CR knows its default MS.

- Name List Server (NLS) : is constructed by the DNS-like tree according to the name hierarchy. NLS is only used to find the corresponding MS which stores the binding information of the requested name since CR sends the NRS lookup request to its default MS whether it has the binding information of the requested name or not. MS is located at the second level NLS and we have utilized the IP for the communications between MSs and NLSs.

3. Mapping System for Name Resolution Service in CCN

This document presents the new implementation of NRS-MS functions based on extension of CCNx to show usefulness of NRS in CCN. We design a simple scenario to maximize NRS usefulness and to understand NRS functionalities easily.

- Scenario : Similar with CDN approach, multiple media servers containing popular contents can be deployed in different areas, but all of media data in replica servers (RSs) must have equivalent name to keep data integrity as a single publisher’s authority. In order to take an advantage from the replica servers, NRS can be utilized to lookup the physical locations of the replica servers. The nearest replica server can be chosen from the information resolved by NRS.
Design choices: We design and implement a new entity named a Mapping Server (MS) by extension of content router (CR). The MS can be deployed by a single network provider. Moreover, we assume that an ICN edge domain is required to have at least one MS. MS maintains mapping information between name and another name and processes a lookup request and its response. Consumer is not changed. The first hop content router (CR1) like a first hop router should have a communication channel toward a mapping server. We design new messages to implement NRS functionalities just by following the CCNx messages in TLV format [CCNxMessages] by extension of optional fields.

```
+-----+
| MS  |
+-----+
```

```
+----------+   +-----+   +-----+   +-----+
| Consumer |---| CR1 |---| CR2 |---| RS1 |
+----------+   +-----+   +-----+   +-----+
```

```
\`
+-----+   +-----+
| CR3 |---| RS2 |
+-----+   +-----+
```

Figure 1: Replica server scenario

4. CCNx Extension for Name Resolution

We have implemented the NRS for CCN based on CCNx. This means that the name is resolved by Interest and Content Object packets defined in CCNx. We define two types of Interest packets for NRS: Interest for registration (I-reg) and Interest for lookup (I-get) which are sent from a proper CR to its default MS for name registration and lookup, respectively. We also define two types of Content Object (CO) packets: CO-reg and CO-get which are corresponding to the I-reg and I-get, respectively. We have utilized the nested header format used in CCNx [CCNxMessages] to enable the newly defined packets.

4.1. Interest

I-get is an Interest packet requesting the name resolution. It includes two names, MS name and a requested name as shown in Figure 2. MS name is used for forwarding I-get to the corresponding MS. On the other hands, the requested name is used for updating PIT.
At each CR, I-get is sent to its default MS when FIB does not have information for the requested name, where each CR is aware of its default MS’s name so it knows where to send I-get.

Figure 2: Interest packet format for name resolution request

4.2. Content Object

CO-get is a Content Object which is a responding packet to I-get. So, it is used to forward the resolved name. As Figure 3 shows, CO-get
includes two names, requested name and acquired name. CO-get is forwarded by the requested name according to its PIT record toward CR which initiated the corresponding I-get. replying to the name resolution request, I-get.

4.3. Forwarder

Forwarder has been modified to make the I-get and CO-get working properly. Forwarder initiates I-get when there is no information for the requested name in FIB. In general, Forwarder drops Interest when no information in FIB. However, we made a chance to lookup for another name instead of dropping it right away.

It is assumed that each forwarder knows the name of its default MS. So, forwarder can use the MS name when it initiates I-get. MS name is only used for forwarding toward MS but PIT is updated by the requested name which is the second name included in I-get. Therefore, forwarder uses only the requested name in CO-get to forward back to where I-get is initiated.

5. CCNx Extension for Name Management

In order to serve the NRS lookup, the name of data object has to be registered in a mapping server (MS) and its binding information also has to be stored in a MS. Thus, we define 4 different types of the registering name: reg, add, del, and dereg.

- I-reg/CO-reg : registration of new name
- I-add/CO-add : addition of the binding name (A registered name can have more than one binding name.)
- I-del/CO-del : deletion of the binding name
- I-dereg/CO-dereg : deregistration of name

5.1. Interest

I-reg is an Interest packet to register a name and store the binding information in a corresponding MS. As figure 4 shows, I-reg includes three names: MS name, registering name and binding name. MS name is used for forwarding I-reg toward MS and registering name is used for updating PIT. Similarly to I-get, I-reg is sent to its default MS.
5.2. Content Object

CO-reg is a Content Object which is a responding packet to I-reg. As Figure 5 shows, CO-reg includes two names, registering name and
binding name. CO-reg is forwarded by the registering name according to its PIT record toward CR which initiated the corresponding I-reg.

5.3. Forwarder

Forwarder has been modified to make the I-reg and CO-reg working properly. When new name is registered to MS, forwarder initiates and sends I-reg toward its default MS. MS name is only used for forwarding I-reg but PIT is updated by the registering name which is the second name included in I-reg. Therefore, forwarder uses only the registering name in CO-reg to forward back to where I-reg is initiated.

6. IANA Considerations

There are no IANA considerations related to this document.

7. Security Considerations

[TBD]

8. Acknowledgements

[TBD]

9. References

9.1. Normative References


9.2. Informative References


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