A Content Provider Mobility Solution of Named Data Networking

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***Abstract*—In this paper, we proposal an content provider mobility solution of Named Data Networking (NDN) [1]. Here content provider means the host of NDN network which provide content originally.**

We add a *Locator* are to the Interest packet [2]. Mapping System also introduced into the network, which maps identifier to locator. The original name is used as *identifer*. Thus, matching lookup in Content Store (CS) and Pending Interest Table (PIT) employs identifier, while forwarding lookup in Forwarding Information Base (FIB) employs locator. In reality, Mapping System should be a DNS-like distributed system, so the record updating has time latency.

It's hard to solve provider mobility when there is no explicit "where" information, that's why locator is imported in NDN, however, "where" still serves as the secondary information of the network.

***Index Terms*—NDN, CCN, Mobility, Mapping System, Locator**

I. Introduction

Named Data Networking (NDN) is one of the promising design of Information Centric Network (ICN). NDN should support mobility, which is widely employed. We distinguish *"(content) consumer mobility"* and *"(content) provider mobility"* based on type of moving node, or say the mobile. Researches agree content consumer mobility can by easily solved by re-issue, which owes to *pull model* and *stateless session*. However, there are also comments that ICN, including NDN, faces challenge of content provider mobility.

Currently design of NDN can support provider mobility theoretically. The provider announce its new accessing point after mobility event happen. All the routers update the corresponding entry in the FIB, then the network work correctly. But in practice, updating information would flood the network, which make it inefficiency, even crash.

Why does the problem become so hard? End-users and applications care *What* they need and the network is in charge of discovering the "what". So there are two tasks of NDN network: recognition and routing. Routing is to find the "what" while recognition is to identify the "what". NDN architecture focuses on users' need: what. It employs name to as identifier to recognize. As to the network, no label is specialized to forward, except for name. Thus, network use name as label to route in order to discover content, which works not well when content provider is stable. Problem become complicated when content provider moves. Name, as identifer, can't be change; so the network has to change the rules of discover the name, which means changing all the corresponding records of FIB.

So we import Locator, as routing label, into the *network*, which doesn't include the "end-user or the applications".

II. Design

A. Locator

First we assume existing of locator. Every content in NDN network has its provider. The provider connects to the network via an accessing point. The locator is given by the access point and describe the address of the provider in the network topology.

Our solution add Locator label into Interest packet however, it's not the end-host label the packet ideally, which makes the Locator totally in the network. But end-host labels the packet will be more effective and simpler. It's a trade-off, and currently we choose the later one.

B. Mapping System

How do end-host and ingress router get the locator of an Interest packet. Here we employ a mapping system, which map name to a locator. In reality, the mapping system should be a DNS-like distributed system, which means end-host and ingress query from the local mapping resolver, just like DNS resolver, and the resolver handles the querying and return a locator.

The mapping system should include other modules in order to implement Load balance, QoS guarantee and union cache. If the provider.

Mapping system records should be updated after a content provider moves to a new access point, which means mobility, just as DNS update.

C. Interest Packet Handling

All providers have home AS and access AS, which In most case, are the same one. Providers register on both local mapping system with its name prefix and current locator. When provider moves, it register again on its new access AS, notify the old access mapping system and home home mapping system to update their record.

On the end-host, application want to get an specified content, it create the Interest packet. And NDN stack will query the local mapping system to get the Locator and fill the Locator area inside the Interest packet. Then the Interest is forwarded inside the AS. When it is forwarded to another

AS, the ingress router of the new As will query its own local mapping system and change the Locator area and the Interest packet is forwarded inside the new AS. This procedure repeat and repeat until the corresponding data is found or the Interest arrive at the original AS of the data.

If the Interest packet arrives at the original AS, and the local mapping system find corresponding provider has moved to another AS, then the AS change the Locator label according to the mapping system record, which forms triangle routing. And data packet trace back following an triangle path without re-send Interest packet.

D. Locator Design

Locator is used as routing label. Better design would make less records in FIB and faster. We proposal two Locator designs:

- IP: IP is existing resource, which can be also used as Locator. Network Address Translator (NAT) could also work inside the AS.
- AS number: AS number could be used as inter-domain routing.
- Network Topology Based design: Design a new highly aggregative locator according to the network topology.

III. Discussion

A. Performance

Query the mapping system to get the locator may takes a relatively long time, however, in practice, matching in CS, PIT and FIB is parallel. But FIB is indexed by Locator and Locators' aggregation performance better than name, which means the time gap can be used to query. What's more, ingress router can be placed near the host of local mapping system and employs a huge query cache.

There are also efficiency reducing during the triangle routing stage after mobility event happens. But in most case, mobility happens inside the AS.

B. Local Locator and Global Locator

There is another exploration, we limit the range of validity of the label inside the AS, which means, when an Interest packet is forwarded to a new AS, the ingress router will change a label according to its strategy. The advantage of changing label according to AS strategy is obvious:

- Load balance: If specified intra-AS link is in heavy traffic or congestion, it can change change to the other path.
- QoS Guarantee: end to end in the AS transmission delay can be detected and also dynamically adjusted by change end to end traffic, which used the same method with load balance.
- Cache Copy Distribution and Union Cache: Interest packet doesn't have to be routed to its provider, if the ingress router is aware of the nearest cache copy, can route the Interest packet to the cache node. Intra-AS union cache can by easily implemented if ingress router label the packet, because Interest packet can be routed based on cache copy distribution.
- Provider Mobility Solution: Locator label is imported in the routing plane, which helps to solve mobility. This is also the application we describe in this paper.

IV. Conclusion

We decouple the namespace of Identifer and Locator we import Locator as secondary NDN label, which mainly solve provider mobility. Name is still the main label of NDN, Locator is used and managed by the network to find contents, which well supports provider mobility. A specified label used to discover contents also benefits a lot, such as FIB scalability and routing lookup.

Future work includes detailed locator design and range of validity of locator, and of course, code implementation and experiment.

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