Efficient Content Awareness Forwarding Strategy in Content Centric Network

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Abstract

Content Centric Network (CCN) is a new paradigm for today network, run by two types of message: Interest (question) and Data (answer). Content centric network architecture is quite different from today one. It carries Content name instead of source and destination addresses. This paper proposes an Efficient Content Awareness Forwarding Strategy that chooses reliable interface for sending Interest and receiving Data. It forwards the Interest depends on the rank of the interfaces with globally routable name prefix.

1. Introduction

The Internet architecture is inefficient for current usage like a content distribution. Content Centric Network (CCN) [1] is the new architecture for future Internet and alternative way to look at networking. CCN is driven by the two types of packets, Interest and Data .CCN nodes use an Interest to request a Data. The Data is a Content object (videos, documents, etc.). In CCN, consumers do not need to care where the data is located. The data can be directly requested at the network level and any node with requested data can answer. CCN node floods Interest to all available interfaces and neighbor nodes might hear the interest. If the requested data is there, router will send back Data to requested nodes by reversing paths. Data is transmitted only to response the Interest packet. For flow balance, one Interest is for one Data chunk. The basic idea of the CCN is to provide a data delivery service regardless of where the data was located.

2. Related work

The core CCN forwarding engine has three main parts: Forwarding Information Base (FIB) that forwards interest packet to Data source(s), Content Store (CS) that stores incoming Data and Pending Interest Table (PIT) tracks Interest forwarded .CCN content name is a hierarchical and is also referred as the prefix or name prefix. It consists of globally routable name, organizational name and convention/automatic (version numbers and segment numbers) .Fig 1 is the example of Data name.

The layers architecture is also differnet from today netwrok. IP is important for today architecture and Content name is an important part of CCN(see fig 1)[1].Statregy layer is one of the new layers in CCN and it departs from today layers architecture.Strategy layer makes decision for choosing interfaces. There are different kinds of forwarding strategy: adaptive forwarding [2], flooding and smart flooding [4].In [2], authors described a forwarding scheme which makes a decision based on status of the interfaces with color (green: interface brings data back, yellow: it is unknown and red: the interface is down), RTT, rate limit and routing preferences. Interfaces are ranked by the routing policies. For example, if the policy is forwarded by status, forwarding strategy would be choosing green interfaces. Our propose strategy, the interface is ranked by the effective successful ratio for each globally routable name. Higher values have higher chance to get Data.

2.1 CCN Forwarding Process

The Strategy layer is a decision maker for choosing interface in order to forward Interest. There are several forwarding strategies: best route, smart flooding, flooding and so on.

When a CCN node receives the Interest, it matches the Interest prefix with Content Store entry. If Data located in Content Store, the Data would be sent back through the Interest requester faces. Otherwise, the Interest prefix is matched with the entire PIT entry. If the PIT entry is matched with Interest prefix, the Interest is already received from another consumer and forwarded earlier. So the router drops the Interest and adds the Interest requester interface to the existing PIT entry. If the Interest does not match with the PIT entry, the Interest prefix will add into PIT and forwarded to the neighbor nodes through the FIB.

Each Interest packet carries Data name and also nonce which is randomly generated by the consumer (requested node). Nonce used to prevent retransmitting same Interest again and again.

When CCN node receives Data, it removes the FIB entry, checks in the PIT and sends Data back to all interfaces. PIT list requested Interfaces, which can be one or more. Data is stored in the content store for next user request and remove the PIT entry. If nobody replies for requested Data, Interest will be removed from PIT when the lifespan expires.

Figure 1 Data Name

3. Efficient Content Awareness Forwarding Strategy

In this section, we would like to describe an Efficient Content Awareness Forwarding Strategy (ECAFS) which forwards the Interest based on the rank of the interface related with globally routable name. Choosing the reliable paths and reducing the data storage on the cache of intermediate nodes are the main goal of the propose forwarding strategy. In here, reliable path means that path can get requested Data in higher probability with minimum delay.

3.1. Global Name Table

We construct a new table to classify Interest prefix and list rank of the interfaces. The Global Name Table (Fig 2) consists of Global Name field and Face List. Global Name field keeps globally routable name and Face List stores the interface list with rank. The least frequently used globally routable prefix entry will be removed from Category Table to reduce the table size.

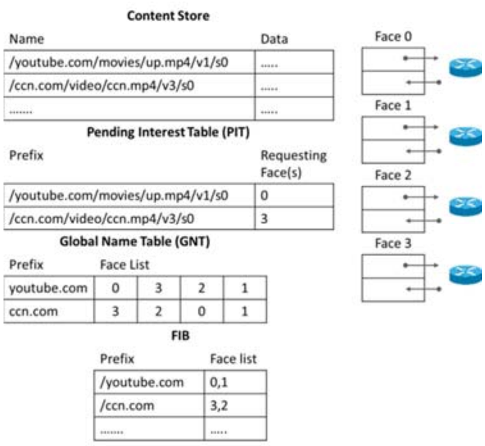

Figure 2 CCN forwarding engine model for CAEFS

3.2 ECAFS process

CCN node receives an Interest, it matches the prefix with Content Store entry first. If Interest does not match with Content Store entry, the CCN node will try to match with PIT entry. The router still cannot resolve the requested Interest and it needs to forward to the neighbor nodes. These processes are same as in [1]. To forward Interest, CCN node needs to choose the interfaces with higher ranking for requested Interest related with globally routable name. Figure 3 shows the process of the ECAFS. The Interest is forwarded by the three types of process. If the globally routable name of the Interest is new, the forwarding strategy will choose Initial process. If not, it will choose Normal process. When the forwarding Interest on higher ranking interfaces is nearly expires, the strategy will choose retry process.

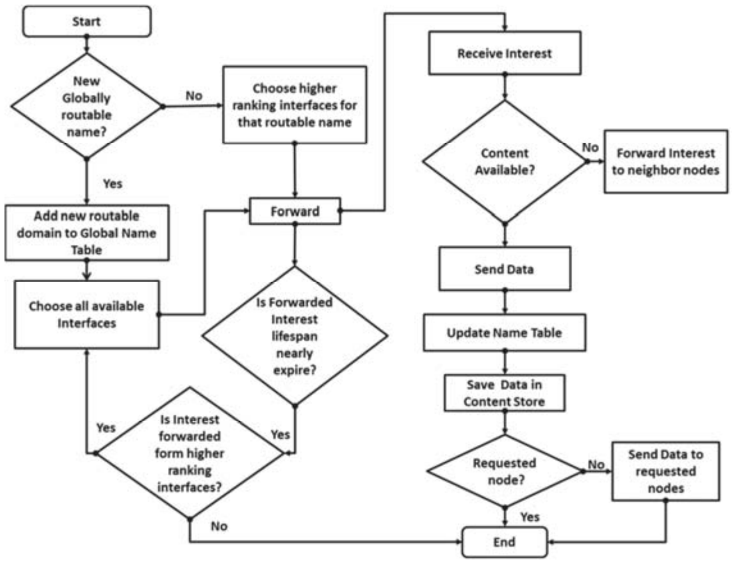

Figure 3 ECAFS process

Initial process: When CCN node needs to forwards Interest, it checks the globally routable name of the Interest and matches with Global Name field from Global Name Table. If the globally routable name for requested Interest does not exist in the entry, the router will add new entry and forward the Interest to all available faces. At initial stage, all interfaces are equal rank and router floods the Interest through all available interfaces to find all possible paths to get Data. The interfaces ranks are updated when router gets the request Data.

Normal process: If the globally routable name for request Interest is already exists, CCN node will choose the higher ranking interfaces for that name prefix. CCN Node can choose the best one or more interfaces depends on the forwarding policy.

Retry process: When Interest lifespan in PIT is nearly expired, which is forwarded on the higher ranking interfaces. In this case, Interest forwarded node considers the forwarded Interest is failed and needs to retry. That situation might be happened, when the Data source is changed or the link is broken. The CCN node flood Interest on all available interfaces to find new paths again. In this stage, if no Data response back for retry request, CCN node will give up for that Interest request. Globally routable name entry from Name table and prefix from PIT table are removed.

In figure 4, consumer 1 sends Interest (globally routable name is youtube.com) to CCN router 1.Router 1 checks the Interest and it new. So Router 1 floods the Interest to all available interfaces. Intermediates routers flood Interest again and again.

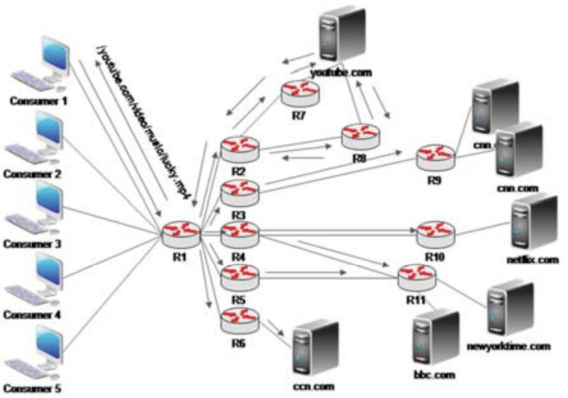

Figure 4 Example for forwarding scheme

At last, Data source found and Data send back to reverse paths. All routers on the path update the Global Name Table. CCN routers do not need to flood Interest again, when the other consumer wants Data (same routable name e.g.Youtube.com). If Interest that forwarded from higher rank interfaces and is nearly expired, the router will be retried by retry process. If retry process is expired, the Interest will be discarded.

Table 1 Notation Table

$ERTT_{ik}$	Effective round trip time for domain k on face *i*
$ARTT_{ik}$	Average round trip time for domain k on face *i*
π_{ik}	Successful ratio for domain k on face *i*
D_{ik}	Total receiving Data packages for domain k on face *i*
I_{ik}	Total sending Interest packages for domain k on face *i*
R_{ik}	Data receiving time for domain k on face *i*
S_{ik}	Interest sending time for domain k on face *i*
N_{ik}	Number of Data packages for domain k on face *i*

3.2.1 Interface ranking

Rank of the interface is depended on the effective round trip time. Effective round trip time is the product of successful ratio (π) and average round trip time (ARTT). The effective round trip time (ERTT) is expressed as follows:

$$ERTT_{ik} = \pi_{ik} ARTT_{ik} \ . \quad (1)$$

Successful ratio for each globally routable name is

$$\pi_{ik} = \frac{D_{ik}}{I_{ik}} \ . \quad (2)$$

Total receiving Data packages for globally routable name k on interface *i* is divided by Total sending Interest packages for domain k on interface *i* .By using this calculation, we can estimate reliable paths to get data.

Average roundtrip time is

$$ARTT_{ik} = \frac{R_{ik} - S_{ik}}{N_{ik}} \ . \quad (3)$$

When CCN node sends an Interest, it marks the sending time *S* and forwards to the neighbor nodes through available interface. If the Data found, the Data sent back via reverse paths .ARTT is updated, when the node received Data. We can estimate the distance between Data and requested node.

4. Simulation results

In this section, we present the simulation results for normal CCN Flooding strategy and ECAFS (see Fig 5). We created single consumer, single router and 7 producers on ndnsim. Consumer requests Data from two producers. The successful ratio of ECAFS is about 80% and Flooding is almost 30%.

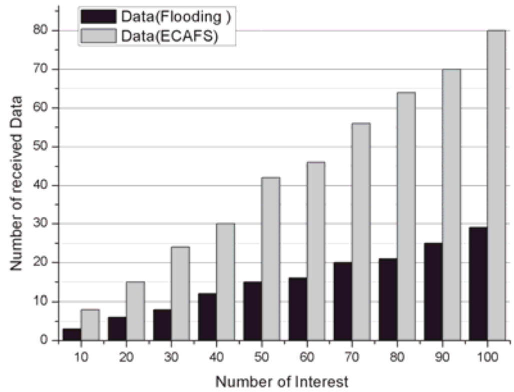

Figure 5 Send Interest vs. received Data

5. Discussion and Conclusion

We presented Content aware Interest forwarding strategy that can choose reliable path to reach data source and to get data. This forwarding strategy is designed to reduce data storage on intermediate nodes, to reduce overhead of Interest flooding and to quickly retrieve data. For future work; we will analyze this strategy with other on ndnSim and test on CCNx.

Acknowledgement

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[3]CCNx<https://www.ccnx.org/>

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