# An efficient Interest delivery scheme using Named-data Link State Routing Protocol and Interest NACK in NDN

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Abstract

For forwarding Interest efficiently in Named Data Networking (NDN), the routing is the foundation where each node is assigned a name rather than an IP address. The packets are also routed by names rather than the source and destination IP addresses. For routing the packets, it requires routing protocol. In this paper, we discuss the use of Named-data Link State Routing Protocol (NLSR) and Interest NACK in NDN for an efficient Interest delivery. The NLSR is used for building the Forwarding Information Base (FIB) so that the router can forward Interests and computes next-hops. In case the router fails to forward user Interest, it returns back the Interest NACK to the downstream router. The Interest NACK can help the downstream router to build Link State Database (LSDB) and take the decision on which alternative path to use, even if the router has not yet received the Adjacency Link State Advertisement (LSA).

## 1. Introduction

In the current IP routing, with the help of IP address, for forwarding the packet, the router uses Forwarding Information Base table to determine the next hop. The next router then repeats the same procedure and so on until the packet reaches destination. In other hand, in NDN the user sends an Interest and the router forwards it and maintains its state in Pending Interest table (PIT), which is used to bring the data packet back to the user. In the NDN, each Interest is associated with lifetime and when the lifetime expired, the Interest gets discarded from PIT. For minimizing the Interests drop, in this paper, we use Interest NACK, by default it is disabled in ndnSIM (Software specialized for NDN simulation). When the router fails to forward the Interest, it returns back the NACK to the downstream router for trying other paths [1].

In IP networks, each router (or node) is assigned an IP address for communicating with other routers, but in NDN network each router is assigned a name. The router publishes its name prefix for the content that it wants to serve. These advertisements are propagated through the network, then each router builds its Forwarding Information Base (FIB) and computes next-hops. FIB entry contains the name prefixes and one or multiple next-hops in which the router may use to forward Interest packets that match the name prefixes of the FIB entry [2].

NDN focuses on contents rather than the destination IP address of the host that has the content. In NDN there are two types of the packets, the Interest packet is used for requesting the content and the data packet is transmitted in response to the Interest packet (in the reverse path of Interest packet).The routing information and Interested NACK are generated by the routers and routed in forms of Interest and data packets.

In the similar paper written by Yi, Cheng, and et al, on adaptive forwarding in named data networking, page 64 [1], they have specified that the Interest NACK is sent to the previous node and not on the source node. This may create a loop in the network due to the interests' retransmission. To overcome this challenge, we are proposing that, once a router fails to forward Interest, to send back the Interest NACK to the downstream router for trying its own alternative paths. If the Interest forwarding failure continues, then the downstream router repeats the same procedure until the Interest NACK reaches to the user.

## 2. NDN routing

### 2.1. Interest Forwarding

In the NDN, each node has three tables, Forwarding Information Base (FIB), Pending Interest table (PIT) and Content Store (CS).

For the received Interest, the router checks if the data requested by the user is cached in the CS, in case it finds the data, the data packet that carries both the name and content is returned back to the user. Otherwise, the router continues for checking in PIT, if it finds the same request in PIT, it attaches the interface on which the Interest arrives to the interface list of the matching PIT entries, but In case of contrary, the new PIT entry is created. The router continues for checking in FIB to find-out in which next hop to forward the Interest. Once a router forwards an Interest, it starts a timer and when the data packet comes back within time interval; it means that there is no problem in the path. Otherwise, there might be something wrong in the path and the router tries other paths and ranks the failed interface. If the router failed to find another path, it returns back the Interest NACK to the downstream router for trying its own alternative paths. If the Interest forwarding failure continues, then the downstream router repeats the same procedure until the Interest NACK reaches to the user.

Interest NACK has the three important parts, Interest Name (failed Interest); Nonce (the nonce carries a randomly generated 4-octet long byte-string) and Error code. Error code (NACK Loop, NACK_Congestion, NACK Giveup PIT, etc) is associated with the description in which explains the reason why the Interest cannot be forwarded; so that the proper action may be taken accordingly such as selecting an alternative path.

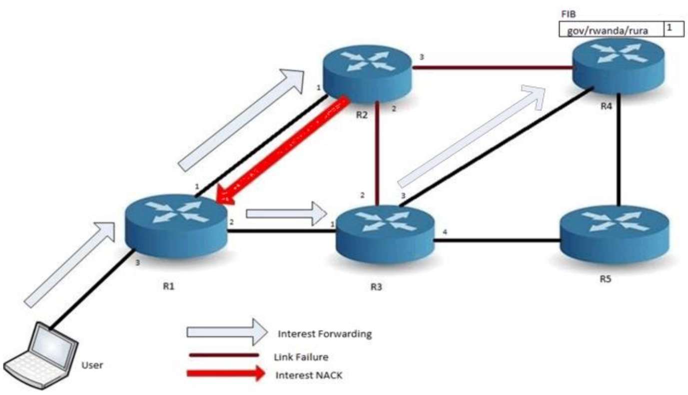


Figure1: Interest NACK return process

In the above Figure 1, the user sends an Interest for the content available in the router R4, the Router R1 forwards Interest to the router R2 through interface 1. R2 failed to forward the Interest due the links failure and returns back Interest NACK to R1 so that R1 tries its alternative path. The alternative path for R1 is to forward Interest to R3 through the interface 2.

### 2.2 Proposal for Interest delivery scheme

In NDN, Named-data Link State Routing Protocol (NLSR) has two types of the messages LSA, LSA prefix in which contains the name prefix registered a router and LSA adjacent in which contains all interfaces of the router. NLSR uses the Adjacency LSA (Link State Advertisement) to advertise the active links, Neighbor's names, links cost to its neighbors. In order to form adjacency, the node sends periodic info Interest to its neighbor and once it receives the feedback, it means that the neighbor is alive [2]. LSA is fetched in the network and the routing table is updated. Each info Interest is associated with its lifetime and once there is no feedback from the neighbor, the node considered its neighbor as down, but it continues to send these info Interests for checking if the neighbor is up .

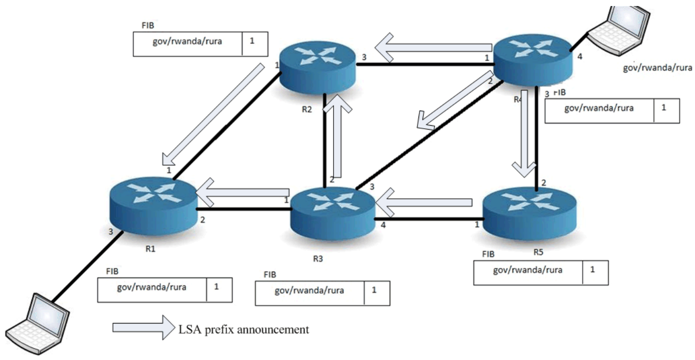


Figure 2: LSA prefix announcement

In the above Figure 2, the router R4 announces its prefix gov/rwanda/rura and the routers R2, R3, R5 receive the announcement through the interface 3, 3, 2 respectively and then build their FIB entries. Also the router R2 and R3 forward the announcement to their neighbor routers.

For preventing unnecessary traffic in the network, in a router, the Interest NACK can replace the Adjacency LSA.

In this paper, we consider that the Adjacency LSA can be replaced by Interest NACK in one scenario for building LSDB. LSA prefix is always needed for advertising the name prefix.

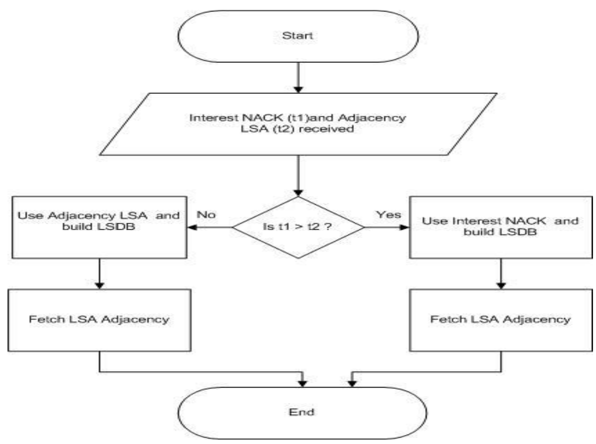


Figure 3: Interest NACK and NLSR in NDN

In the above Figure 3 shows the scenario where Interest NACK can replace the Adjacency LSA. t1 is the time that the router receives Interest NACK and t2 is the time that the router receives Adjacency LSA.

If t1>t2, it means that the Interest NACK is more recent than LSA. The router uses Interest NACK to build LSDB and tops up to the maximum the lifetime of failed Interest. The router tries another path for retransmitting the failed Interests and forwarding the new Interests.

If t2>t1: it means that LSA is more recent than the Interest NACK. The node uses LSA to build LSDB and checks if the problem specified before by Interest NACK was solved or not.

The router uses Dijkstra's algorithm for calculating the cost of each link to reach every destination node and the next-hops for reaching each destination.

In view of the above, the bellow Table 1 is the qualitative evaluation of different NDN routing, where the type of packets, failure & recovery, and multipath calculation were considered as evaluation parameters.

| NDN | Type of packets | Failure and recovery | Multipath calculation |
|---|---|---|---|
| NDN without Interest NACK and NLSR Protocol | Interest packet and data packet | It uses the Interest lifetime. Once the lifetime expired without getting the data back, the Interest is sent again | No |
| NDN with NLSR Protocol | Interest packet, data packet, and Info Interest packet | The nodes exchange LSA messages for adjacency forming and recovery | Uses Dijkstra's algorithm for finding the next-hops |
| NDN with Interest NACK and NLSR Protocol | Interest packet, data packet, Info Interest packet, and Interest NACK | In additional to LSA messages, when the Interest forwarding failed, the nodes exchange the Interest NACK in which has error code associated with description | Uses Dijkstra's algorithm for finding the next-hops |

Table 1: Evaluation of NLSR protocol and Interest NACK in NDN

### 2.3 Future Works and Conclusion

The use of NLSR and Interest NACK together in NDN can minimize the number of Interests being dropped. With the help of Interest NACK, the router can build FIB and take the decision on which interface to use, even if the router has not yet received the Adjacency LSA.

In the future works, we will carry-out evaluation experiments of this proposal.

## 3. Acknowledgement

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