Demo Overview: Reliable Contents Retrieval in Fragmented ICNs for Disaster Scenario

Tomohiko Yagyu
NEC Corporation
Kawasaki, Japan
yagyu@cp.jp.nec.com

Shuya Maeda
NEC Solution Innovators Ltd.
Hiroshima, Japan
maeda-sxb@necst.nec.co.jp

ABSTRACT

Aftermath of disaster, e.g., earthquake, existing communication infrastructure such as cellular networks will be severely damaged. A large number of user terminals suffer disconnection from central servers. Due to the fault of BaseStations(BS) and cable cut between BS and Backhaul, network is fragmented into portions. Because of the novel capabilities such as name-based communication and in-network caching, Information Centric Networking (ICN) is one of the promising technologies to support reliable communication among such fragmented parts of network. This demo presents dynamic name-based routing and reliable contents retrieval among fragmented networks with NDN (Named Data Networking) architecture in the context of disaster situation.

Categories and Subject Descriptors

C.2 [Computer-Communication Networks]: Network Architecture and Design, Network Protocols

Keywords

Information Centric networking; Fragmented networks; Disaster recovery; DSDVN;

1. INTRODUCTION

Named Data Networking (NDN)[1] is one of the promising ICN architectures. Name based communication is useful not only in ordinary cases but also in disaster cases. Aftermath of disaster, existing communication infrastructure such as the Internet and cellular networks will be severly damaged. If DNS (Domain Name Syatem) becomes unavailable, users can't access URL or FQDN at all. With ICN, the victims can retrieve desired information without resolving server's IP address. However, current NDN architecture basically assumes well connected networks such like wired or densely populated wireless networks. PIT entry is short-lived, e.g., a few seconds, and message arrival is not guaranteed. In case of disaster, due to the fault of BaseStations(BS) and cable cut between BS and Backhaul, network will be fragmented into portions. We call thus partitioned network the fragmented network. To achieve reliable content retrieval in fragmented networks, we designed routing protocol and retransmission mechanism suitable for fragmented networks. We implemented proposed solution on top of CCNx [2] for the proof of concept.

ICN'14, September 24–26, 2014, Paris, France.
ACM 978-1-4503-3206-4/14/09.
http://dx.doi.org/10.1145/2660129.2660131.

2. PROPOSED SOLUTION

In the disaster case, a large number of people take refuge in shelters. Even if each shelter has a local network, it may not have connection to other sites. Hundreds of people share limited precious resources in a shelter. The motivation of our soluiton is to realize efficient and reliable content retrieval by NDN protocol in fragmented networks without congestion and waste of resources. Our solution comprises of two technologies, i.e., dynamic routing and retransmission control. Our proposed routing protocol has two roles in the solution. One is to establish route to name prefixes, another is to detect the state of connectivity in the networks. Proposed retransmission control achieves reliable message transmission via intermittent links. Unlink original NDN, our scheme employs hop by hop retransmission rather than retransmission by end nodes. This relies on long-lived PIT. Thanks to the routing protocol, intermittence of the routes toward the target name can be informed to end nodes. Therefore it is possible for end nodes to adjust lifetime of $Interest$ (and PIT entry) in accordance with the network conditions. Though current solution uses fixed long lifetime, we will develop dynamic lifetime adjustment mechanism in future.

2.1 Routing protocol

We developed dynamic name-based routing protocol for fragmented networks, namely DSDVN. DSDVN is based on the wellknown adhoc routing protocol DSDV[3]. DSDV is a distance-vector protocol for MANET. We chose the distance-vector protocol to support fragmented networks rather than link state protocol (e.g., OLSR[4]) or reactive protocol (e.g., AODV[5]). There are two reasons as follows.

1) DSDV doesn't need to flood messages throughout the network. In fragmented networks, it is very hard for all nodes in the network to receive same message due to the intermittent connections. Unlike TC message in OLSR or RREQ message in AODV, DSDV has to inform only direct neighbors of its routing information. This mechanism is suitable for the fragmented networks.

2) It is easy to manage control overhead. In the disaster cases, it is a critical problem to minimize control over-

head due to the resource (bandwidth, energy, etc) shortage. Distance vector protocol can reduce control overhead with simple way, i.e., making message interval longer. It is also easy to estimate overhead because no control messages are forwarded beyond one hop away.

DSDVN extends DSDV to convey name prefix information in the routing message. In the fragmented networks, connection between nodes are intermittent. DSDVN has a role to manage the state of links ,i.e., *connected* or *disconnected*, with the potential neighbors. This status is set to $Face$ in CCNx and utilized to control retransmission described in the next section. With DSDVN, even if the nexthop becomes *disconnected*, the routes remain valid for a while untill the node learns new valid routes from connected neighbors.

2.2 Retransmission control

To achieve reliable contents retrieval via intermittent links, it is useful to retransmit messages in hop by hop manner. On the other hand, restransmission of messages should be minimized to avoid network congestion and reduce energy consumption. For the disaster application, lifetime of $Interest$ sent by end users should be much longer than that in ordinary case, e.g., 1 hour. While end users suppress retransmission, intermediate routers should be responsible for forwarding messages. Routers retransmits $Interest$ iff PIT entry exists and status of $Face$ of nexthop node is *connected*. Figure 1 shows a message sequence with proposed retransmission mechanism. In the figure, an end user sends $Interest$ to the adjacent router (router1). Suppose that FIB entry toward the publisher is populated by DSDVN in advance. The end user waits for the content for a long time. When router1 receives $Interst$ from the user, it creates PIT entry and forwards the $Interest$ to the nexthop (router2), then starts retransmission timer for it. Because the nexthop node toward the publisher (router2) is disconnected with router1, router1 suspends retransmission of $Interest$ even if PIT entry exists. When router2 is connected with router1, router1 resumes retransmission until $ContentObject$ is received. When router2 received $Interest$ from router1, it also creates PIT entry and starts retransmission timer. When router2 goes away from router1, router1 suspends retransmission again. When router2 moves close to the publisher (nexthop in FIB entry), router2 retransmits the *interest* and receives $ContentObject$ from the publisher. Although router2 tries to forward $ContentObject$ to router1 based on the PIT entry, it fails beacuse router1 is disconnected. As NDN principle, $ContentObject$ is not retransmiited to avoid waste of resources. Router2 caches the content and removes PIT entry. When router2 is connected with router1 again, router1 retransmits $Interest$ to router2. Then router2 replies $ContentObject$ because it cached the content. Router1 forwards $ContentObject$ to the user based on the PIT entry.

3. DEMO SETUP

This demo shows dynamic routing and content retrieval via $DataMule$. The fragmented network in demo is emulated with our wireless network emulator. Figure 2 shows the setup of this demonstration. There are six nodes in this scenario. $Gov.Office$ has the repository and provides some contents for refugees in shelters. $Gov.Office$ periodically advertises route information for the name-prefix $ccnx : //government$ by DSDNV. The route information

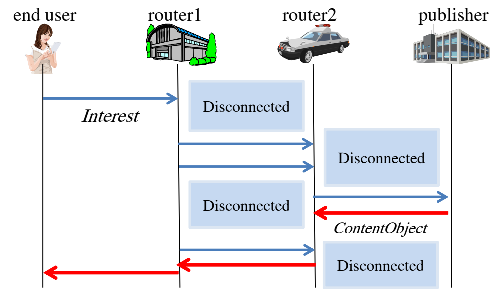

Figure 1: Message sequence

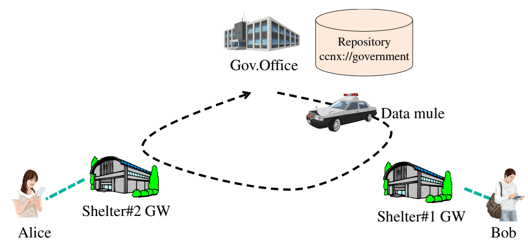

Figure 2: Demo Setup

is propagated to $DataMule$ and GWs. There are two shelters in the region. GWs provide wireless access (e.g., WiFi) to persons,e.g., $Alice$ and Bob, in the shelters. $Gov.Office$ and GWs are fragmented due to the damage to the communication infrastructure. $DataMule$ is a vehicle mounted ICN router on. $DataMule$ conveys messages and contents between $Gov. Office$ and persons in shelters. The demonstration shows that $Alice$ and Bob can retreive map information from the repository in $Gov.Office$ via $DataMule$.

4. CONCLUSIONS

In this demo we show our proposed solution which achieves reliable contents retrieval in fragmented ICNs. We designed routing protocol and retransmission mechanism suitable for fragmented network with intermittent connections. This approach enables victims in disaster area to retrieve desired information without frequent retransmission of $Interest$, namely less consuming battery in their terminals.

5. ACKNOWLEDGMENT

The work for this paper was partly performed in the FP7/ NICT EU-JAPAN GreenICN project.

6. REFERENCES

[1] V.Jacobson, D.Smetters, J.Thorton, M.Plass, N.Briggs, and R.Braynard, "Networking Named Content," in Proc. ACM CoNEXT 2009, Dec. 2009, pp.1-12.

[2] CCNx implementation, http://www.ccnx.org/

[3] C. Perkins and P. Bhagwat, Highly dynamic destination sequeneced distance vector routing (DSDV) for mobile comptuers, In proc. ACM SIGCOMM pp.234-244,1994.

[4] T. Clausen and P. Jacquet, Optimized Link State Routing (OLSR), IETF RFC 3626, 2003

[5] C. Perkins, E. Belding-Royer and S. Das, Ad hoc On-Demand Distance Vector (AODV) Routing, IETF RFC 3561, 2003