Demo: Seamless Mobility as a Service on ICN

Asit Chakraborti, Aytac Azgin, Ravishankar Ravindran, and Guoqiang Wang
Huawei Research Center, Santa Clara, CA, USA.
{asit.chakraborti, aytac.azgin, ravi.ravindran, gq.wang}@huawei.com

ABSTRACT

In this demo, we present our service-centric mobility support architecture using Information-centric Networking, with emphasis on Producer mobility. We implement our solution over a CCN-based service platform, with multiple end-hosts running video-conferencing application acting as Consumer and Producer, to demonstrate its capability to achieve seamless handover.

1. INTRODUCTION

`Information-centric Networking` (ICN) aims to re-design the Internet architecture by moving towards a content-centric design [4], where named content becomes the principal entity for information dissemination. Among candidate designs, content-centric networking (*i.e.*, CCN or NDN) has become the leading architecture to represent ICN. CCN/NDN based architectures typically utilize hierarchically structured names and a pull-based approach to content delivery, for which authenticity is provided through digital signatures carried within packets. Despite the flexible support such architectures provide to retrieve content from anywhere in the network, such an approach by itself becomes insufficient to handle content delivery from mobile hosts (Producers) due to factors such as overwhelming overhead associated with rerouting requests (Interests) towards mobile hosts, and unpredictable delays introduced by on-demand resolution after handovers [2].

Existing approaches to handle Producer mobility in CCN/NDN (see [5] for a recent survey) are typically host-driven, where the Producer is responsible for announcing its reachability to the network and triggering related changes in the network to enable routing continuity (*e.g.*, [6, 1]). However, these approaches can introduce significant signaling/ transport overheads and are susceptible to security concerns with the potential of triggering routing churns. Network-driven approaches can minimize such concerns as the mobility state is tracked and controlled by the network to offer a more robust and resource efficient service for content delivery from mobile hosts [3]. In doing so, we can also offer a stable routing/forwarding plane, where mobility state is only restricted to nodes that serve as a point of attachment, while avoiding potential problems like routing churn. In this demo, we demonstrate one such solution, which expands on our earlier architecture [3] (which was limited to simulations) to realize it as a service-centric mobility support architecture using CCN, where we introduce new components at the content routers to handle seamless mobility.

Permission to make digital or hard copies of all or part of this work for personal or classroom use is granted without fee provided that copies are not made or distributed for profit or commercial advantage and that copies bear this notice and the full citation on the first page. Copyrights for components of this work owned by others than ACM must be honored. Abstracting with credit is permitted. To copy otherwise, or republish, to post on servers or to redistribute to lists, requires prior specific permission and/or a fee. Request permissions from permissions@acm.org.
ICN'16, September 26-28, 2016, Kyoto, Japan
© 2016 ACM. ISBN 978-1-4503-4467-8/16/09...$15.00
DOI: http://dx.doi.org/10.1145/2984356.2985240

2. MOBILITY-AS-A-SERVICE ARCHITECTURE

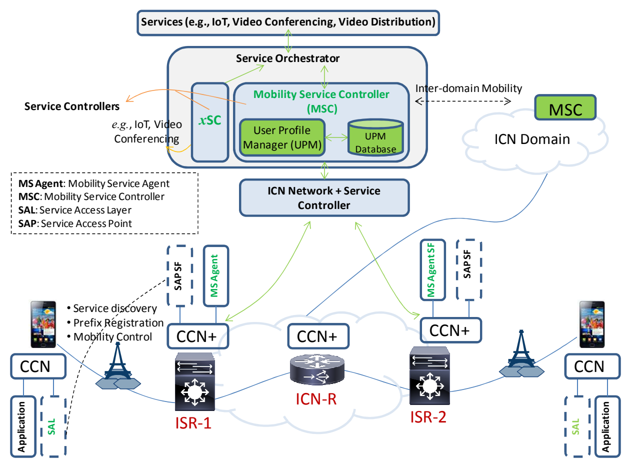
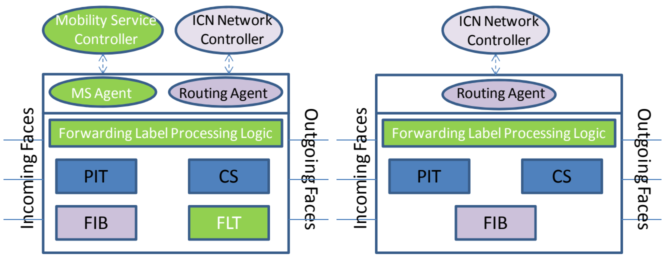


Figure 1: Architectural components to support mobility.

We present the proposed architecture in Figure 1, which is realized over a CCN based service platform, and where we have (*i*) the `Service Orchestrator` that exposes application programming interfaces to heterogeneous services to request and manage desired services with meta information such as geographical distribution of demand and/or performance requirements; (*ii*) the `Network Service Controllers` (NSCs) where requested services are translated to provisionable resources and passed on to; (*iii*) the `ICN Service and Network Controller`, of which `ICN Service Controller` manages the ICN service functions that can be plugged in any ICN Service Router (ISR) and `ICN Network Controller` manages the dynamic provisioning of system resources (*e.g.*, Forwarding Information Base, FIB) based on service requirements. Mobility service is handled through the `Mobility Service Controller` (that is part of NSC), which manages the associated service profiles (which may include services and their service level agreements, allowing MSC to push policies to ICN infrastructure to support mobility for service flows) and name-to-locator mappings (mappings of request names to locators utilizing ID/locator split) through the `User Profile Manager`. Mobility service is provided to end hosts by the `Mobility Service Agent` (MS-Agent) at the ISRs, which is responsible for (de-)registration of service names requiring mobility support and resolving names to locators by communicating with the MSC. `Service Access Layer` (SAL) and `Service Access Point` represent the control plane functions responsible for the discovery of ISRs and mobility services. SAL also acts as a proxy for the application to handle signaling for the mobility service.



(a) ICN service router. **(b)** ICN relay node.

Figure 2: Architectures for the ISR and ICN-R nodes.

Packet forwarding at the ICN layer is handled by the ISRs and ICN Relay (ICN-R) nodes, for which the architectures are shown in Figure 2. To support mobility as a service for routing, we utilize: (*i*) an optional `Forwarding Label` (FL) header within Interests to carry the locator information, (*ii*) `Mobility (Service) Flags` within Interest/Data headers to identify supported flows and to trigger supported functions at the ICN routers, and (*iii*) a newly introduced data structure at the edge service routers (*i.e.*, ISRs), referred to as `Forwarding Label Table` (FLT), which stores name-to-locator mappings. FLT is implemented as a hash-table supporting longest-prefix matching, and its entries are controlled by MSC through either on-demand resolution (*e.g.*, at the time of first request of a flow) or proactive provisioning. Forwarding logic for the mobility-service enabled Interests uses the following steps (different from regular CCN processing): (*i*) check whether FL is set or not within Interest, (*ii*) if FL is set, validate FL (which allows for FL swapping), and if not, communicate with MS-Agent to acquire the FL and update FLT and Interest, and (*iii*) perform FIB lookup on FLT output or content name.

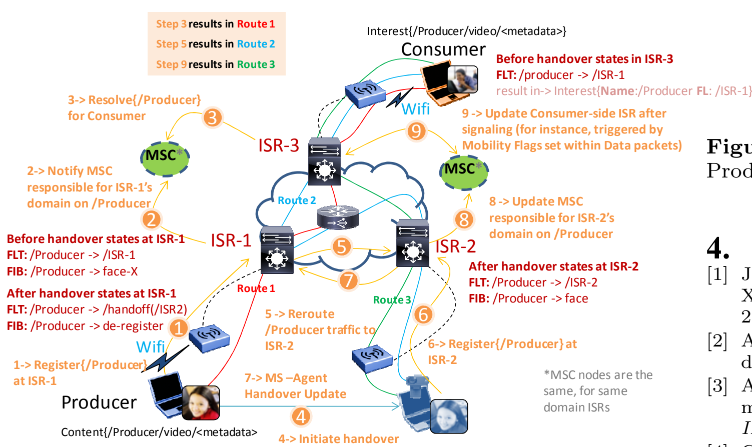


Figure 3: Events taking place during handover shown on the Demo scenario.

We illustrate the mobility operation in Figure 3, which shows the steps involved in registration, resolution, and handover phases. More specifically, our solution triggers the following steps during the handover: (*i*) MS-Agent hosted at ISR-1 provides Producer with a candidate ISR list (*e.g.*, based on physical layer stats) pre-handover; (*ii*) Producer selects ISR-2 from that list for handover and initiates the handover; (*iii*) ISR-1 updates FLT entry for Producer to point to candidate ISRs and proactively forwards received Interests targeting Producer to candidate ISRs (ISR-2 in demo scenario) after updating the FL; (*iv*) Producer registers with MS-Agent at ISR-2; (*v*) MS-Agent at ISR-1 is informed with the registration, to forward traffic only to ISR-2; (*vi*) MS-Agent at ISR-2 updates MSC with up-to-date registration information on Producer.

3. DEMO SCENARIO

The demo setup includes multiple ISRs/ICN-R nodes running a multi-threaded TLV based version of CCNx enhanced for mobility support. ISRs host virtualized MS-Agents and Conference Service Agents (as virtual machines) provisioned with OpenStack; and ONOS provides Network, Mobility and Service Controller functionalities. Producer and Consumers (laptops) run the same version of CCNx. Producer connects with ISRs over WiFi, and it can connect either to one ISR at a time, or simultaneously to two ISRs at the physical level. CCN communication uses only one connection at any point in time. Handover is initiated by an explicit signal at the Producer or as a result of signal strength variation from the ISR. We demonstrate almost seamless experience among fixed and mobile participants involved in audio/video conferencing, as the results illustrate in Figure 4 for one of the considered scenarios.

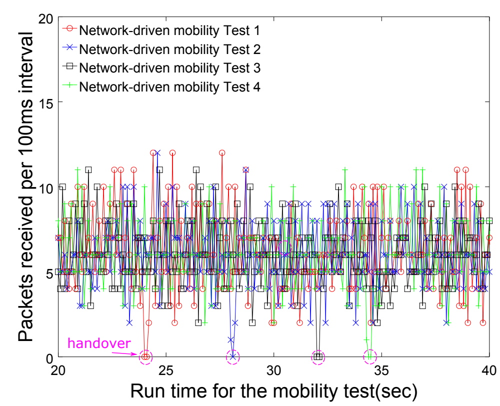


Figure 4: Throughput experienced by a Consumer, when the Producer uses multiple wifi adapters.

4. REFERENCES

[1] J. Auge, G. Carofiglio, G. Grassi, L. Muscariello, G. Pau, and X. Zeng. Anchor-less producer mobility in ICN. In *ACM ICN*, 2015.

[2] A. Azgin, R. Ravindran, and G. Wang. Mobility study for named data networking in wireless access networks. In *IEEE ICC*, 2014.

[3] A. Azgin, R. Ravindran, and G. Wang. A scalable mobility-centric architecture for named data networking. In *IEEE ICCCN SCENE*, 2014.

[4] G. Xylomenos, C. Ververidis, V. Siris, N. Fotiou, C. Tsilopoulos, X. Vasilakos, K. Katsaros, and G. Polyzos. A survey of information-centric networking research. *Communications Surveys Tutorials, IEEE*, 16(2), 2013.

[5] Y. Zhang, A. Afanasyev, J. Burke, and L. Zhang. A survey of mobility support in named data networking. In *IEEE INFOCOM NOM*, 2016.

[6] Y. Zhang, H. Zhang, and L. Zhang. Kite: A mobility support scheme for NDN. Technical Report NDN-0020, NDN, 2014.