Demo: Named-Data Networking in Opportunistic Networks

Extended Abstract*

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ABSTRACT

This document describes the demo of our NDN-Opp framework which brings Named-Data Networking to Opportunistic Networks. Our implementation attempts to leverage all communication opportunities, supports intermittently connected device-to-device communication links and push models. We are also experimenting with acknowledgement mechanisms and connection-less transfer of packets.

CCS CONCEPTS

• **Networks** → *Network design principles*; *Link-layer protocols*;

KEYWORDS

named-data networking, opportunistic, device-to-device

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1 PROBLEM STATEMENT

The rise of device-to-device (D2D) capabilities in mobile devices foreshadows that such type of communications will play a significant role in the networks of the future. In this work, we seek to explore how NDN might offer advantages for supporting such type of communications along with new types of applications. Our opportunistic scenarios involve communications between devices without relying on any type of infrastructure so that devices can exchange content with one another directly. Such scenarios encompass situations where network is not available (e.g. in case of an emergency away from a city center) but also when data can be exchanged directly between devices. The core contribution of NDN-Opp is to bring together NDN to opportunistic networks by enabling devices to exchange data directly with one another without relying on the existence of an infrastructure nodes or access points. Instead of requiring their presence as part of its design, these can be utilized as interesting alternatives when encountered.

2 OVERVIEW OF SYSTEM COMPONENTS

In this section, we describe the architecture of NDN-Opp as depicted on Figure 1.

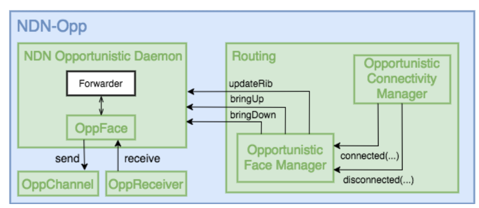

Figure 1: Overview of the architecture of NDN-Opp

The **NDN Opportunistic Daemon** encapsulates all the forwarding logic, strategies and tables of NFD [4, 5]. It also includes support for two push-communication mechanisms; Long-Lived Interests (LLI) [7] and pushed Data (pData) [2]. LLIs only differ from standard Interests in that they are not removed from the PIT when matching Data is received. pDatas are a special type of data packets which do not follow the standard breadcrumbs but are forwarded based on the FIB. To use them, a node advertises it is a consumer for some content through the routing protocol.

The **Opportunistic Face** implements a queuing system in order to cope with the intermittent nature of the links between devices. This enables the standard flow of Interest and Data packets to go on undisturbed. The **Opportunistic Channel** and **Opportunistic Receiver** encpsulate the logic for transmitting and receiving packets on the lower-level channel used. In our original implementation [3], we used TCP connections to perform the transfers between two directly connected devices because of the restrictions of the Android API. To address this issue, we built a support for connection-less transfers into NDN-Opp by using the service

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discovery of the probing phase as a means of exchanging packets [1]. The **Opportunistic Face Manager** maintains the opportunistic faces corresponding to known peers. It also manages the RIB to attach discovered name prefixes to them and allows to use them opportunistically. The **Opportunistic Connectivity Manager** manages the channels used to communicate with other peers.

In terms of routing, we seek to design a routing protocol based on more stable metrics than the usual ones. Social-aware routing has been already studied in recent years [6]. In the context of understanding which type of routing would be required to support the types of scenarios envisionned in this work, we investigate which contextual information (e.g. shared interests of peers, visited networks) would provide the appropriate stability. Furthermore, this information could be helpful in guiding the decisions of whether to pass pending Interests to a peer upon encountering it for the first time.

NDN-Opp is available both as source code[1] and an application package for Android devices. Currently NDN-Opp is only being tested with internally developped applications. However, its design is backwards compatible with NDN and existing applications should work directly on top of it.

3 DEMONSTRATION

In our demonstration, we seek to illustrate four functionalities of NDN-Opp which we describe in the subsequent paragraphs. The topology considered is presented in Figure 2. Initially, devices R and T are within communication range of one another.

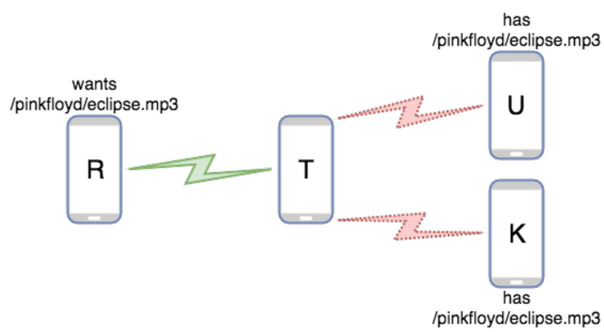

Figure 2: General scenario. Device T has seen device K previously but has never seen device U before.

Scenario 1. A user (R) is interested in some piece of content and requests it from its user application. At that point, only peer T has advertised a valid route for a name prefix (i.e. `/pinkfloyd`). Peer T decides to forward the Interest to K which is the data source but as the latter is not within communication range, the packet is queued instead. Once K comes within range, the Interest is passed and it responds with the matching data. At this stage, the breadcrumbs can be followed which results in the data packet being stored in the queueing system until device R comes within communication range again. In this scenario, all Interest and Data exchange occur exactly in the way mandated by NDN; Interests are stored in the PITs of the devices and Data follows back along the breadcrumbs. While it may be possible for device T to satisfy the Interest if it has the data in its content store, this would not work in all situations where the data is available elsewhere.

Scenario 2. The same situation is considered in this scenario; device R expresses an Interest which is stored in the queue at device T. However, before getting within communication range of K, device T encounters a previously unknown device (U). Through the exchange of contextual information regarding the prefixes device U can serve, device T makes the decision to opportunistically pass its pending Interest. Device U immediately responds with the matching data and the breadcrumbs are followed back in the same way as earlier.

Scenario 3. A user (R) is in need of assistance in a remote area and uses an application to advertise that fact. The application can construct a pData packet with relevant information (e.g. nature of the emergency, geolocation) and push it in an emergency namespace (e.g. `/emergency`). As another user (T) quickly drives by without noticing user R, her device picks up the pData through a connection-less transfer. Upon reaching a more crowded area, device T can push the request for help further, either based on its previously known routing or through opportunistic communcations.

[1] http://github.com/COPELABS-SITI/ndn-opp

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