Efficient Content Dissemination in Heterogeneous Networks Prone to Episodic Connectivity

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Categories and Subject Descriptors

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General Terms

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1. INTRODUCTION

Ubiquity of portable computing devices coupled with wide availability of wireless communication present new important opportunities for applications involving media-rich content dissemination. However, as access networks become increasingly more heterogeneous, seamless data delivery across internets consisting of a variety of network technology becomes a real challenge. In this demonstration, we showcase a system that enables content dissemination over heterogeneous internets consisting of wired–, infrastructure-based and infrastructure-less wireless networks that may be prone to intermittent connectivity. Using an efficient, yet flexible buffer management scheme, we are able to address application-specific performance requirements such as average delay, delivery probability, energy efficiency, etc.

Our system uses the Message Delivery in Heterogeneous, Disruption-prone Networks (MeDeHa) [2]) framework to deliver messages across a heterogeneous internet coupled with History-Based Scheduling and Drop (HBSD) buffer management [1] as a way to optimize resources provided by opportunistic networks. MeDeHa, which is described in detail in [2], provides seamless data delivery over interconnecting networks of different types, i.e., infrastructure-based and infrastructure-less networks. MeDeHa's comprehensive approach to bridging infrastructure-based and infrastructure-less networks also copes with intermittent connectivity. For this demonstration, we showcase a "complete stack" solution featuring, from to top to bottom, the DTN2 "bundle" layer, HBSD as an "external router" to DTN2, and MeDeHa, which handles message delivery. We have implemented, on a Linux-based testbed, *(i)* the MeDeHa framework, *(ii)* the HBSD [3] external router for the DTN2 [4] architecture.

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2. ARCHITECTURE OVERVIEW AND IMPLEMENTATION

Our main goal is to cope with heterogeneous networks and to take advantage of content relaying over DTNs in order to reduce communication costs and network resource consumption. In this context, Figure 1 depicts an example scenario targeted by our framework, where we have two infrastructure networks (Ethernet and 802.11) connected to a MANET (nodes running OLSR) and a DTN network (nodes running HBSD and DTN2). Gateway nodes with the MeDeHa framework will interconnect the diverse networks. In the following, we detail the main building blocks of our framework with respect to Figure 1.

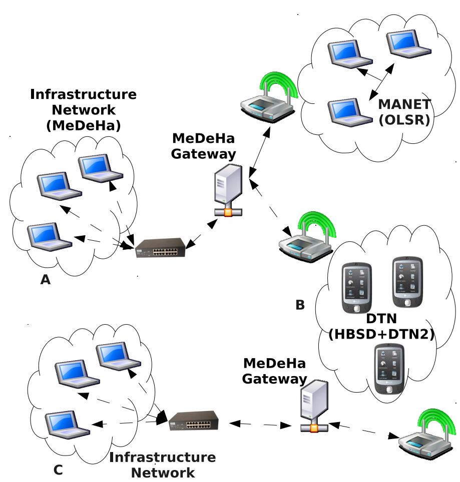

Figure 1: Example scenario.

MeDeHa nodes deployed within the infrastructure network (running the MeDeHa protocol [2]) have several responsibilities, including finding paths (or a suitable relay, gateways in this case) to a destination across all connected networks (even MANET or DTN) and exchanging topological and routing information to aid in relay selection. MeDeHa nodes also store data for other unavailable nodes, or transfer custody to better suited relay (based on some utility metric).

MeDeHa gateways [2] are simply MeDeHa nodes that are connected to and forward content between multiple networks. With respect to the scenario presented in Figure 1, MeDeHa gateways provide interface for communication with two opportunistic networks, *(i)* A MANET network running the OLSR protocol, and *(ii)* An Epidemic DTN Network running the optimal HBSD scheduling and drop policy on top of DTN2. We define the former interface as a MeDeHa-MANET gateway, as shown in Figure 3, and the latter as a MeDeHa-DTN gateway, as shown in Figure 2.

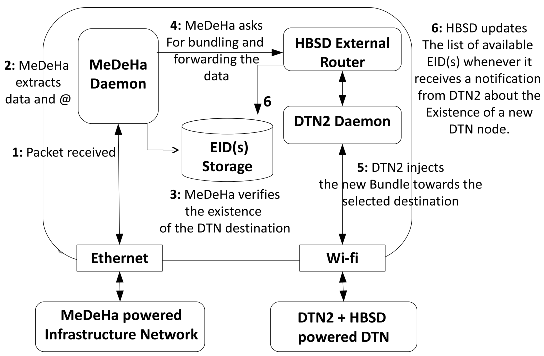

Figure 2: MeDeHa-DTN gateway architecture.

Whenever a new packet is received through the Ethernet interface of a MeDeHa-DTN gateway, the MeDeHa daemon extracts the packet data and IP addresses, and verifies whether this packet is destined to a node within the adjacent DTN network or to another Internet node beyond the DTN network. If the packet needs to be forwarded to the DTN network, the MeDeHa daemon asks the HBSD external router to create a *bundle* that encapsulates the required packet fields and data. In a last step, the HBSD external router forwards the created bundle towards another MeDeHa gateway beyond the DTN network or towards a DTN node. Thanks to the HBSD external router running on both the gateway and DTN nodes, bundles forwarding within the DTN network are optimized towards either decreasing the bundles average delivery delay or increasing their average delivery rate.

The same control flow is reproduced for the MeDeHa-MANET gateway described in Figure 3. However, unlike the DTN gateway, there is no need for a mapping process between different data types or between different naming schemes. The MeDeHa daemon takes the responsibility of interfacing with the MANET underlaying routing protocol (OLSR in this case) in order to identify the packet's next hop which can either be a local MANET node or a MeDeHa gateway if the packet needs to traverse the MANET network.

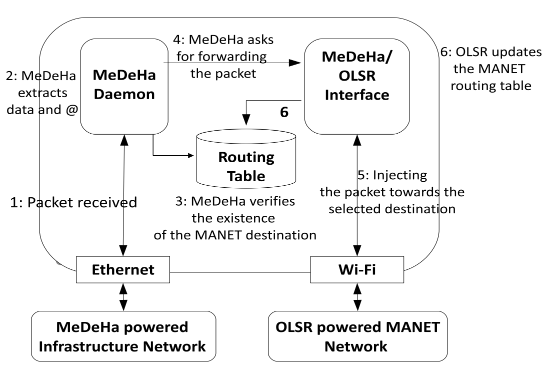

Figure 3: MeDeHa-MANET gateway architecture.

2.1 Hybrid Simulator Integration

We integrate our MeDeHa ns-3 simulator implementation with the testbed through ns-3 emulation and real-time scheduling capabilities, as shown in Figure 4. Specifically, we use ns-3 TAP to bridge part of the simulated network to the testbed network. This works by creating a "ghost" node on the ns-3 network that passes all Ethernet frames between a Linux TAP device on the real node and the simulated links to which the ghost node is connected. Packets can then be routed between the simulated network and the networks to which the real node is connected.

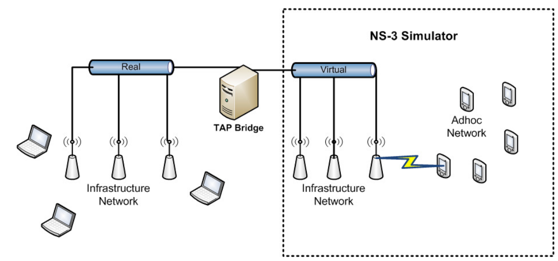

Figure 4: A sample hybrid network with both real and virtual ns-3 nodes

3. DEMONSTRATION

The demonstration will showcase our implementation of the MeDeHa protocol and the HBSD external router as well as their joint ability to perform optimized message delivery over heterogeneous networks. Our target scenario consists of two infrastructure networks bridged via opportunistic networks (highlighted with dash arrows in Figure 1).

Our demonstration testbed will consist of Linux laptops and Android Smartphones: some laptops will be connected to two different infrastructure networks and will run our MeDeHa gateway while the other nodes communicate opportunistically on an epidemic DTN network. The intermittently-connected DTN stations will run our HBSD external router on top of DTN2. Additionally, a portion of the infrastructure network as well as an OLSR MANET will be be simulated (Figure 4) to extend the scenario beyond what would be available given limited equipment.

4. ACKNOWLEDGMENTS

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5. REFERENCES

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