Epidgeons: Combining Drones and DTNs Technologies to Provide Connectivity in Remote Areas

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ABSTRACT

In certain geographical areas such as the rural areas or the developing regions, the lack of infrastructure, the temporary nature of the connections and the limited access to fixed public networks does not allow the use of all the advantages offered by the Internet. In this paper we present our project that aims to test a new communication system based on the combination of the use of unmanned aerial vehicles (called *ePidgeons*) and wireless networking technologies for Disruption Tolerant Networks (DTN). As a study case we will use the riparian communities along the rivers in the Amazon region.

1. INTRODUCTION

Even though the initial architectural designs of Delay Tolerant Networking (DTN) [1] mainly focused on deep-space communications, the networking research community witnessed the realisation of appealing prototypes that aim at using this technology in other contexts, e.g., to support Intelligent Transport Systems (ITS). DTNs can improve the connectivity possibilities of very sparse and remote rural areas. When permanent real-time connections are not possible, due to economical or geographical reasons, solutions for at least non-real-time applications such as voice mail, email and blogs should be searched. Asynchronous modes of communication can be offered at a significantly lower cost and without necessarily sacrificing the functionality required to deliver valuable end-user services, being sometimes also more practical and socially appropriate for end-users where communications infrastructure is shared.

One of the first examples is the research project N4C[2] that focussed on developing Internet for the remote regions. Another interesting example of a very low cost asynchronous communications infrastructure is the DakNet project [3]. DakNet combines physical means of transportation (vehicles) with wireless data transfer in order to extend the Internet connectivity provided by a central uplink or Hub (e.g. a cybercafe) to kiosks in surrounding villages. Instead of trying to relay data over a long distance DakNet transmits data over short point-to-point links between kiosks and portable storage devices called Mobile Access Points (MAPs). Mounted on and powered by a bus, motorcycle, or even bicycle, the MAP physically transports data among public kiosks and private communications devices (as an intranet) and between kiosks and a Hub. More recently, the combined use of drones and DTN has been considered as an alternative for environmental observation [4, 8], or for emergency situations [5].

In our approach we want to improve the MAP idea reinforcing the idea of the combined use of drones, combined with previous results as described in [6, 7]. The drones will allow the systems to reach villages in areas where the terrain makes complicated, and in certain periods of the year impossible, the access of other means of transportation but trying to keep the overall data delivery perceived to the users, as small as possible.

2. THE EPIDGEONS PROPOSAL

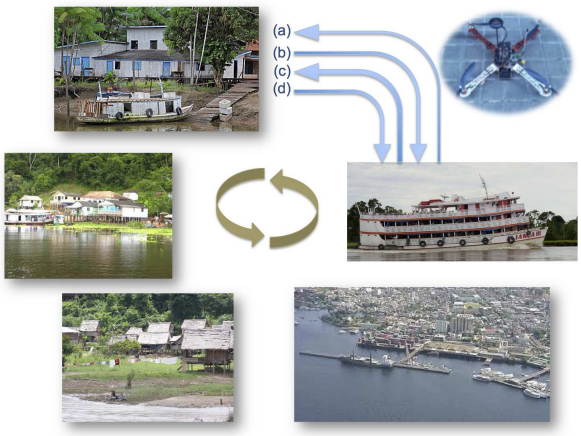

Figure 1: Overall view of our proposed solution.

This paper describes the overall idea of a project to alleviate the phenomenon called “digital divide” in geographical environments such as rural areas or devel-

oping regions. Figure 1 presents an overall view of our proposed solution. More specifically, we propose to design and test a novel communication system based on the combination of three elements: (1) the use of unmanned aerial vehicles ("drones"), (2) the technologies used for Disruption Tolerant Networks (DTN), and (3) the regular traffic of boats on the river. This is a joint project with researchers from the Universidade Federal do Amazonas in Manaus (Brazil) that are involved in various activities aimed at deploying data networks to connect small villages along the Amazon River.

The DTN technologies, the basis of this project, implement a switching architecture based on the process of storing and forwarding messages. A new protocol called the "bundle layer" (or *message layer*) is introduced between the application layer and the transport layer. The main objective of this new layer is to join different heterogeneous networks together. What the bundles basically provide is a communication link among different networks regardless of the lower layers behaviour.

The basic idea is as follows. The villages will be provided with low cost units, for example based on Raspberry Pi devices (http://www.raspberrypi.org/) or similar boards, developed to offer local users an access point to the distributed network. These devices, called "village access points" (VAPs) by means of a specifically designed software, will accumulate the requests for Internet access, whether email, file transfer or web queries, in *bundle* format.

Similar devices, but with larger storage capacity, called "boat access points" (BAPs) will be placed on the boats that circulate with regular frequency in the river. The boats will also carry our ePidgeons. An ePidgeon will be a drone with an on-board unit (OBU) based on a light and cheap board. The drones will be programmed to reach the different villages at the VAPs locations. Once there, the ePidgeon will synchronise with the VAP, downloading the recently stored request bundles (incoming) and uploading the carried response bundles (outgoing). This task will have a duration that is dependent on the number of requests/responses and the size of data that each of them involves. We consider 5-10 minutes a reasonable time frame to allow interchanging about 1-1.5 GB. Once synchronised with the VAP, the ePidgeon will return to the ship to recharge and prepare for the following intervention; as represented by steps (c) and (d) of Figure 1. The users at the villages can continuously store bundles at the VAPs and will get their respective response bundles once transported there by the drones.

The BAPs will interact with the ePidgeon controlling and setting the next route and transferring the data (bundles) to be delivered to the next village, and downloading and storing into the BAP the data (bundles) obtained in the previous villages, from the VAPs. Finally, when the ship reaches the port area of Manaus, or other Internet-connected ports, the BAP will execute the last phase of the process, synchronising with the Internet the incoming and outgoing bundles and preparing for the next trip through the river beginning a new phase of data delivery to villages.

This project will allow the experimentation with many different technical facets of the main problem that we try to handle. We think that the feedback that we will acquire will allow us to improve specific techniques related to: (1) Identifying the applications that are the most necessary to offer to the population and at which performance level, (2) how to adapt the possible heterogenous user devices so they can participate, (3) the maintenance and use of drones (ePidgeons), and many more

3. CONCLUSIONS

Drones and Delay Tolerant Networks technologies could be successfully combined to provide a novel solution to alleviate the phenomenon called "digital divide" in geographical environments such as rural areas or developing regions. In this paper we presented the overall idea of an architecture based on these two tools, that we aim to deploy in the coastal communities of the rivers of the Amazon region to obtain empirical feedback to advance the knowledge base in this field.

4. REFERENCES

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