A gateway for wireless broadcasting

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ABSTRACT

Ad-hoc wireless peer-to-peer methods are an important and viable alternative to the more traditional infrastructure based ones for distributing contents among a population of users. The PodNet project is a ongoing effort to create a broadcasting system for delay-tolerant content, in which peer nodes exchange contents opportunistically when within range, and their mobility acts as a complementary mechanism for the dissemination. This paper introduces the design of a PodNet node. In particular, the special case of a gateway, which bridges the infrastructure world of the Internet and the ad-hoc domain, is considered.

1. THE PODNET SYSTEM

The goal of the PodNet project is to create a wireless broadcasting system for a variety of content; the only requirements that the said content is delay-tolerant. Nodes employ store-carry-forward to distribute content in an opportunistic manner; mobility is used as the primary means of dissemination. The content is organized into channels, analogous to traditional radio broadcasting. A user subscribes to one or more *private* channels, which the device requests content for when it peers with another device. Nodes additionally carry a number of *public* channels on behalf of other nodes to promote greater diversity of content.

A gateway differs from other PodNet nodes by an Internet connection, utilized for retrieving content. It is generally a fixed, high capacity platform, but a mobile implementation, e.g. using a 3G connection, is also plausible. The gateway acts as a bridge between the infrastructure world of the Internet and the ad-hoc content exchange domain. The interaction with a gateway is thus transparent from the perspective of a general roaming node. A gateway can utilize channel popularity metrics, obtained from peer contacts, to optimize its caching strategies. Future applications include interconnecting multiple gateways into a content distribution overlay to perform intelligent prefetching and caching of content.

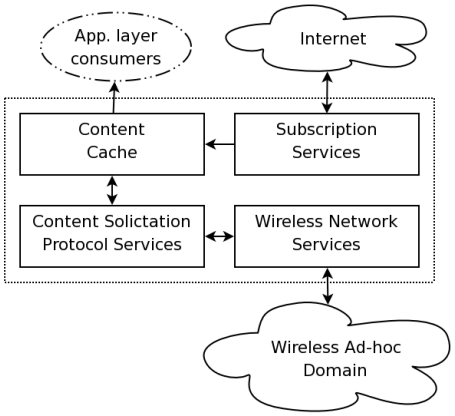

Figure 1: Gateway node diagram

The basis for this work is [1, 2] which outline the philosophy of the PodNet system. The body of work on delay-tolerant networking, e.g. [3], store-carry-forward and epidemic methods, e.g. [4, 5], are of particular interest due to the dissemination method employed. Opportunistic dissemination systems have been described previously, e.g. [6].

The contribution of this work is: 1) A light-weight solicitation protocol. 2) A modular system design for a PodNet node, in particular considering the special case of a gateway. 3) A proof-of-concept implementation of a gateway, along with a simulation model incorporating an implementation of the content solicitation protocol.

2. DESIGN AND IMPLEMENTATION

A modular system design for a general PodNet node was created, concentrating on the special case of a gateway. It is shown schematically in Figure 1. The content cache is identical to that of general roaming nodes, as are the ad-hoc protocol services. The subscription services pull content off

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the Internet for redistribution in the ad-hoc domain.

A detailed design of the receiver-driven solicitation protocol outlined in [1, 2] was done as part of this work. It is lightweight to maximize content throughput, since efficiency is of prime importance to take advantage of the short and infrequent contacts. Soft state of peers and protocol states is maintained locally on each peer node. The protocol takes advantage of the broadcast nature of the wireless medium to increase efficiency and some concepts are borrowed from promiscuous protocols to reduce overhead.

A proof-of-concept Python prototype of a gateway management system was created, using a relational database for meta-data storage. The prototype is essentially a test platform for the non-trivial task of developing and evaluating suitable cache maintenance algorithms, essential for a multi-channel system to be viable on smaller devices. The design is object oriented, facilitating easy substitution of modules, such as storage engines. Although the prototype subscriber is developed to process Podcasts and Atom/RSS newsfeeds, it is nevertheless flexible enough to allow creation of subscription services for other types of content.

A simulation model, based on the OMNeT++ framework, implements the solicitation protocol described above. It was created for evaluation of the protocol in a controllable environment; a necessary precursor to deployment on real hardware platforms. All effort was made to create platform independent and modular code to facilitate porting to a variety of platforms. A mobility module for the widely used random waypoint mobility model was created, allowing studies of a system within fixed boundaries, with the addition that nodes are allowed to enter and leave the simulation. An additional mobility module, capable of using ns-2 mobility trace files, allows running scenarios created with external mobility generators.

3. EVALUATION

Although the simulation model is developed for investigation of the system behavior as a whole, it has so far been mostly employed for evaluation of the solicitation protocol. Some preliminary results on the performance and characteristics of a PodNet system have though been obtained. An example is shown in Figure 2, which demonstrates the spread of content within a square. The results are for a RWP model in a relatively large 1000x1000m square. The fraction of nodes that have a content item is plotted versus time. The results show that even fairly low node densities are sufficient to spread the content to a significant fraction of the population.

4. CONCLUSIONS AND FUTURE WORK

A prototype for a gateway node has been developed, laying the basis for future development work on the PodNet project. In addition, a simulator model for further analysis work on the system was created, implementing the solicitation protocol. Future utilization of the simulator includes large scale studies of systems with several content channels. The PodNet project is currently in its early stages and a variety of projects are planned, e.g. implementation of the content distribution overlay mentioned in the introduction. A project focusing on formal verification of the content solicitation protocol is also currently underway.

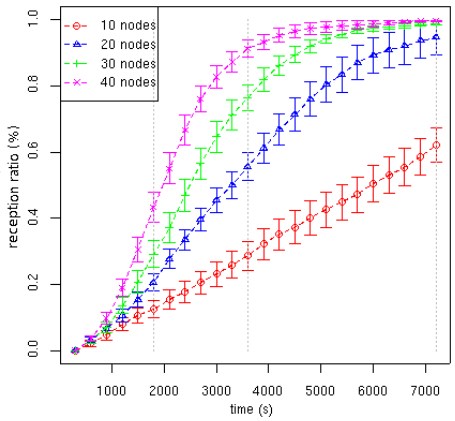

Figure 2: Content spread within a square

5. REFERENCES

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