Poster Abstract: Scalable and Collaborative Internet Access for Opportunistic People Networks*

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ABSTRACT

We propose a Scalable and Collaborative Internet Access approach, called SCIA, for mobile web surfing. Unlike traditional approaches, the proposed scheme implements a *Collaborative Forwarding* algorithm that takes advantage of opportunistic wireless connections, and thus improves network capacity by exploiting the diversity of network mobility. Moreover, using the Layered Multiple Description Coding (LMDC) algorithm, the SCIA scheme allows the end user to 'preview' the web content, even before the data has been completely transferred. Using simulations as well as realistic opportunistic people network scenarios, we demonstrate that the SCIA scheme provides a better web surfing service than traditional schemes, and thus facilitates more effective web surfing on the go.

Categories and Subject Descriptors

C.2.2 [**Compuer-Communication Networks**]: Network Protocols—*Applications, Routing protocols*

General Terms

Algorithms, Performance

1. INTRODUCTION

The last few years have seen an impressive growth in Internet applications. As wireless technologies continue to extend into every part of our living environments, it is becoming increasingly desirable to have a solution that can provide web surfing on the go. In this study, we propose a Scalable and Collaborative Internet Access approach, called SCIA, for mobile web surfing applications. Unlike previous approaches [3, 7, 8] that are basically centralized and fail to exploit the diversity of network mobility [6], the SCIA scheme implements a *Collaborative Forwarding* algorithm to better utilize opportunistic ad hoc connections and spare storage in the network. In addition, it implements the Layered Multiple Description Codin (LMDC) technique [4] that enables the end user to "preview" the web content, even before the data has been completely transferred. Using simulations as well as real-world mobility traces, we evaluate the proposed scheme in terms of service ratio and traffic consumption. The results show that the scheme significantly outperforms previous approaches in all test cases, while its traffic consumption remains moderate.

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2. PROPOSED SOLUTION: SCIA

There are two types of participating peers in the SCIA system: *Gateway Peers* (GP) and *Vanilla Peers* (VP). GPs are connected to the Internet directly, and VPs are peers that do not have Internet access but with local wireless connection capabilities. Note that a mobile peer may switch his/her mode from GP to VP (and vice versa) if it temporarily loses (or recovers) its Internet connection.

There are two cases when a peer A issues an Internet download request: if A is a GP, he can download the content himself immediately; otherwise, A forwards his request, with a replication factor f, to the first f peers he meets in the network. Of course, the larger the value of f, the higher the number of participating peers that will be aware of A's request. The proposed SCIA system is then applied as follows (see Fig. 1). Suppose B is another mobile peer that receives A's request. There are two cases:

1. *If B is a GP*, he immediately downloads the requested content from the Internet, and forwards it to A if they are directly connected (i.e., by the *Direct Forwarding* algorithm). Next, B disseminates the content to the mobile network using the *Collaborative Forwarding* algorithm. Note that the objective of the *Collaborative Forwarding* algorithm is to cache Internet content previously requested by peers in the network. This allows the SCIA system to reduce redundant downloading when multiple peers request the same content.

2. *If B is a VP*, he first checks his local storage to determine whether the requested content has been cached, and then implements one of the following two options:

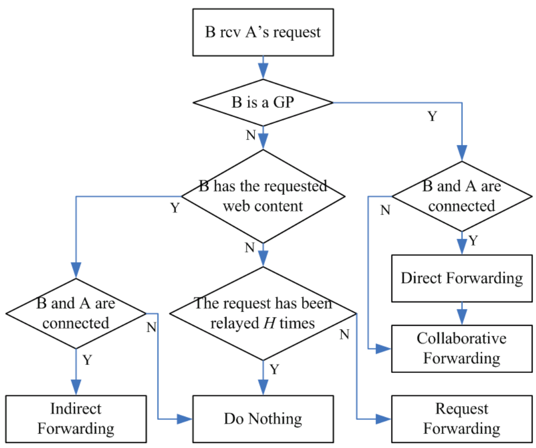

Figure 1: The request process algorithm of the SCIA scheme.

(a) *If B has the content requested by A*, he forwards it to A if they are directly connected (i.e., by the *Indirect Forwarding* algorithm); otherwise, he does nothing. Note that the *Indirect Forwarding* phase is slightly different to the *Direct Forwarding* phase, since B may only have a portion of the requested content (which depends on the underlying *Collaborative Forwarding* algorithm); whereas the complete content is forwarded in the *Direct Forwarding* phase.

(b) *If B does not have the content requested by A*, he forwards A's request to his next encountered peer so long as the request has not been forwarded (from A to B) more than H times (i.e., the *Request Forwarding* algorithm); otherwise, he does nothing.

The collaborative forwarding phase employs the Layered Multiple Description Coding (LMDC) approach to perform content-centric data forwarding in opportunistic networks [4] . Specifically, the LMDC scheme is applied to each MHTML document [9] that is a MIME HTML document enclosing one or more objects, such as text, images, and videos. The layered coding scheme encodes MHTML documents by looking up a pre-determined *codebook*[1], rather than splitting messages into equal-sized pieces. Then, the LMDC scheme implements the Unequal Erasure Protection (UEP) [5], which provides different levels of erasure protection to the layer coded blocks by adding different amounts of redundancy.

3. EVALUATION

We implemented the SCIA and Mobile Hotspots schemes in the DTNSIM simulator. In each simulation run, we randomly selected γ mobile peers as GPs and 20% of the other peers as web surfers. We evaluated two network scenarios based on realistic wireless network traces (i.e., the iMote [1] and UCSD [2] traces). We assumed web surfers only issue HTTP requests in the first 10% of the simulation time, with a Poisson rate of 1,800 seconds/request. We also assumed that data transmission between mobile peers is wireless at a fixed rate of 2Mbps, and that each HTTP request can be relayed at most 2-hops with the replication factor f equal to 4. We selected a set of web documents comprised of the top 500 requested documents according to the hit-count statistics of the proxy server in National Taiwan University for the period Apr.'06 to Sept.'06, and applied LMDC to the selected documents in the simulation. The LMDC codebook presented in [4] was used, and each LMDC coded document was distributed to five distinct relays. The unequal erasure protection technique was also applied, such that the i-th layer was erasure coded with a replication factor equal to $5/i$ (i.e., the i-th quality layer data is able to be reconstructed as long as i out of the five packets are received).

Fig. 2 shows the experiment results with various γ values in the iMote and UCSD scenarios[2]. From the results, we observe that the service time performance of the SCIA scheme outperforms the Mobile Hotspots scheme in all test cases. This confirms our intuition that *collaborative forwarding* can utilize opportunistic connections, and thus better exploit the diversity of network mobility. We also observe that the service ratio improves as the value of γ increases

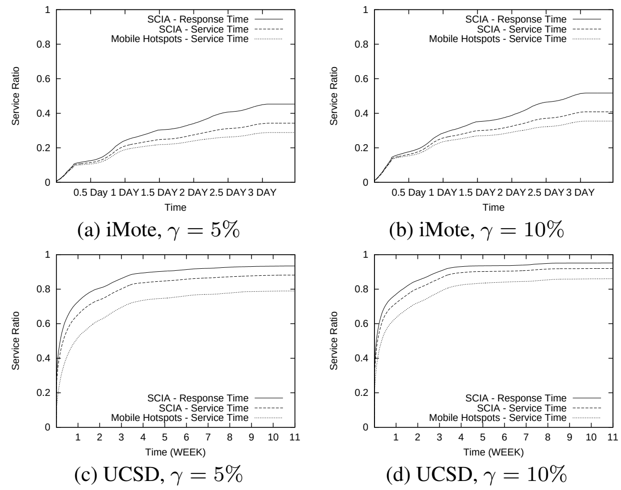

Figure 2: Comparison of the service time and response time performance of the SCIA and Mobile Hotspots schemes.

for all schemes. For instance, when γ increases from 5% to 10%, the service ration of the SCIA scheme increases from 34% to 42% in the iMote scenario, and from 88% to 93% in the UCSD scenario. Moreover, the results also show that the response time performance of the SCIA scheme outperforms the service time performance in all test cases.

4. CONCLUSION

We have proposed SCIA to improve mobile web surfing applications. The scheme implements a *collaborative forwarding* feature to make better use of opportunistic connections among mobile peers, and thereby improves the network capacity by exploiting the diversity of network mobility. Using simulations as well as realistic network scenarios, we evaluate SCIA against a traditional approaches, and the results demonstrate that our scheme can achieve better service ratios with moderate traffic consumption in all test cases. Work on evaluating the proposed scheme with a buffer size constraint is ongoing. We will report the results in the near future.

5. REFERENCES

[1] Crawdad project. http://crawdad.cs.dartmouth.edu/.

[2] Ucsd trace. http://sysnet.ucsd.edu/wtd/.

[3] A. Balasubramanian, Y. Zhou, W. B. Croft, B. N. Levine, and A. Venkataramani. Web search from a bus. In *ACM MobiCom Workshop on Challenged Networks*, 2007.

[4] L.-J. Chen, C.-H. Yu, C.-L. Tseng, H. hua Chu, and C.-F. Chou. A content-centric framework for effective data dissemination in opportunistic networks. *IEEE Journal of Selected Areas in Communications*, 26(5), June 2008.

[5] P. A. Chou, H. J. Wang, and V. N. Padmanabhan. Layered multiple description coding. In *IEEE Packet Video*, 2003.

[6] M. Grossglauser and D. Tse. Mobility increases the capacity of ad-hoc wireless networks. In *IEEE Infocom*, 2001.

[7] D. Ho and S. Valaee. Mobile hot spot in railway systems. In *22nd Biennial Symposium on Communications*, 2004.

[8] J. Ott and D. Kutscher. Bundling the web: Http over dtn. In *WNEPT*, 2006.

[9] J. Palme, A. Hopmann, and N. Shelness. *MIME Encapsulation of Aggregate Documents, such as HTML (MHTML)*. IETF RFC 2557, March 1999.

[1] The design of the codebook can be customized according to an object's size, semantics, importance, and other design choices.

[2] By service time, we mean the interval between the time that a HTTP request is issued and the time that the last byte of the requested web content is downloaded; and by response time, we mean the interval between the time that a HTTP request is issued and the time that the first 'playable' version of web content is downloaded.