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A Proxy-Based Browsing for Reducing Energy and Latency in Cellular Networks

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Abstract —*Wireless networks require longer transmission time and high radio energy usage on mobile devices in comparison to wired networks, as in the process of downloading a web page there are various computations such as HTML parsing, image decoding, page layout etc. My solution is an implementation of proxy based technique in network to reduce energy and latency in mobile devices. In this approach functionality is split between proxy based network and mobile deice. Database of resource list is refreshed periodically by residing proxy on the wired network, so that total number of bits transmitted can be reduced to transfer information between mobile device and network. Results show that this technique reduce around 50% page load time and 65% consumption of radio energy in comparison to traditional cellular web browsers.*

Keywords- *Wireless Networks, Mobile Devices, Web Browsers, Proxy-based Network, Wired Network.*

I. INTRODUCTION

Web browsing in cellular devices is most important application among mobile applications. But web browsing in cellular network is slower due to longer access delays and limited bandwidth and browsing in wireless network is the power-hungry operation so it has been witnessed the growth of data traffic in 3G and LTE cellular technologies lead to losing opportunities of online business.

Due to hundreds of objects in web pages spread over multiple server, and large number of HTTP request-response interactions in downloading web pages make current approaches ill-suited to browsing the cellular network. On the other hand, in wireless cellular networks, there is large round-trip times resulting in longer download times. During the downloading of JavaScript, HTML, CSS may need to identify initial objects to fetch, increases the delays. Short data transfers and higher latencies increases radio energy of mobile deice [1].

It is critical to its optimization to understanding the reason of slow of the browser. It has been concluded that several key compute-intensive operations are the bottleneck in the personal computers browsers and characterization study of a present smart- phone [2] demonstrated that the wireless hop slowing down the browser by its long round-trip time (RTT) [2-4]. On the contrary, the operations such as style formatting, layout calculation [2-4], and JavaScript execution, are the bottleneck in desktop browsers. Smart phones have limited processing power, affecting the resource loading process, as it is associated with network.

Recently, the protocol in accessing the web is modified to reduce the latency in browsing web on mobile devices such as, a new protocol, SPDY [3], designed by Google, minimizes the latency of web browsing by adding request multiplexing. However, this solution requires changing software on client and server side. So the objects of web having short expiration times reduces the efficiency of caching techniques, while incorrect predictions result wasting of bandwidth and battery resources in prefetching solutions in browsing wireless network.

Other solution is a proxy-based network, and unlades various communication functions into the proxy from the mobile client. Proxy carries a much larger communication and computation burden. The certain communication tasks of the mobile client are offloaded to the proxy so that, on behalf of the mobile client the proxy consumes more energy.

In this proxy-based approach, after finishing downloading of all the embedded objects of a page, the proxy builds and transmits the bundle. It takes at least one RTT for fetching and parsing the base HTML file to discover the list of the referenced objects in request-response nature of the HTTP protocol. And before arriving at the base HTML file, there might be one or more redirections involved which delays the web objects realization.

II. WEB DOWNLOAD PROCESS IN MOBILE NETWORKS

Following are the various reasons of slow of download process in mobile network:

A. Page load process

The mobile browser first get the domain address of main page by looking up domain name server and using HTTP protocol, it fetches the main page from the web server, parse the page and updates the Document Object Model (DOM) tree dynamically. It initiates new HTTP requests to the server for the new encountered objects in the page, which are not available locally. There is a need of additional new objects and javaScripts files have to be downloaded to execute downloaded javaScript files as the objects are inter-dependent, results network traffic, consisting number of short data transfers, which is related to TCP connections per domain, lookups DNS to resolve large number of involving servers, and each object's HTTP request/response.

B. Latency measurement

Base HTML fetch time is calculated for 100 Canadian websites [3] from computer connected to an Ethernet of an organization. CDF (cumulative distribution function) of the time to fetch the HTML file for each site has been found. This fetch time will be different from the Round Trip Time between the device and web server due to redirections. The measurement results in [3], it is shown that, to load a page, the largest fraction time of the network is constituted by the base HTML fetch time. So, by eliminating the initial fetch time the performance of the mobile browser can be optimized.

C. Power measurement

The instantaneous power consumption, $P_i = V_d \times V_R/R$ where V_d is the voltage provided to the 802.11 device and V_R is the voltage drop across resistor, R at a given moment. The energy consumed, E for time period, T, E = QUOTE, where there are n samples of instantaneous power P_i during time T (one sample every t_s seconds) [4].

Consider what goes on during transmission of packet, Shows the instantaneous power consumption of a 1064 bytes packet, transmitted in 802.11g band at the rate of 6 Mbps at a transmit power of 63 mW for a Linksys interface.

The instantaneous transmit power during transmission of packet,

$P_{c\Rightarrow} -t| \square\ P_t.(1-e^{RC_1})\ t<\max(c\cdot RC_1,t_p)P_t\ t_r < t < t_p\ | -t\lceil\ P_t.(e^{RC_2})\ t<c\cdot RC_2$

Where $P_t = P_a - P_i$ is the power consumed by the transmission circuit only. RC_1 and RC_2 are the RC components. RC1 for rise of current and RC2 for fall of current. t_p is transmission time of packet and c is a constant. For a packet of arbitrary size and data rate, energy consumption, $E = P_a \times t_p$ i.e. total power consumption of wireless transceiver and from it total energy is calculated.

This model shows that the energy consumed in transmitting a packet is proportional to the size of the packet. So, if the size of the packet is reduced by half, the consumed energy would be half as well.

III. PROXY-BASED NETWORK AND DESIGN

In this proposed proxy-based network is designed on two cooperating proxies, one resides in the mobile device and another, remote proxy in the network, that aims to eliminate the round-trip time required for fetching base HTML file. On behalf of the mobile device the remote proxy in visiting a web page downloads all the required objects, then pushed it to the local proxy in a bundle, serving browser's request locally. By this proxy-based design the page load time can be reduced and by bundling, the unnecessary power is eliminated for each object, so that energy consumption can be reduced [3].

So the proxy-based architecture is designed to meet the objectives are: 1. To minimize pre-object HTTP request-response interactions, in which HTTP request-response interaction with the browser is avoided for individual object, to handle user interaction and dynamic page changes at the client locally to avoid network communication, which gives efficient radio energy interactions, and latency-sensitive and cellular-friendly data transfer to reduce consumption of radio energy by bundling the data to and from the client.

It is shown that, If we splits the browser function into a proxy in the cellular network and a browser installed on the mobile device. On entering a URL, browser request for this URL to the proxy. DNS is looked up on receiving the request, and URL is requested from the web server. The proxy-based network starts to parse web pages on receiving the response from web server, and identify all objects, which are required to render the page successfully. Without the request of the client for them the proxy goes ahead and requests these objects, which are identified earlier. Then it collects all the objects and transfers to the client. The client receives the main HTML page from the proxy and associated objects the page. As the proxy already have fetched the objects, so doesn't requests for these objects by the browser, and made available as part of the collection. Parsing of all CSS files and processing JavaScript is done by the client as part of this process. In this design, the client browser handle all the interactions locally to keep it responsive and energy efficient, While there seems to be work repetition at the client and proxy.

It is observed that the mobile device has an energy cost associated with every bit transmitted or received and the same cost paid by the infrastructure makes this cost irrelevant by accessing to unlimited power supply. So this design will increase the communication and computation burden of the proxy to reduce the burden of the mobile device. And client will be able to send fewer bits and thus energy will be conserved by offloading redundant transmissions and processing to the proxy.

IV. EVALUATION OF PERFORMANCE

Here, to demonstrate the effectiveness of this proxy-based network, the implementation of prototype is used.

A. Experimental setup

The laptop is running Ubuntu operating system with Wi-Fi adapter as mobile terminal. The laptop is equipped with LTE USB modem for cellular measurement to access the LTE network provided by cellular carrier.

Using QWebKit library own browser is developed on the client side, so that detailed timing information can be logged and also programmatically clear the cache of browser before each experiment. By only configuring the browser for using the local proxy any browser can be benefitted from this proxy-based approach.

Through campus LAN of 100 mbps Ethernet, the wireless router is connected to the proxy server to perform WLAN measurements. And cellular experiments are conducted over the LTE network at a high signal strength location. The measured TCP throughput between the remote proxy and mobile device was 52.5 mbps in Wi-Fi and 2.5 mbps in cellular settings. And the RTT between the remote proxy and mobile device was about 10 ms in Wi-Fi and 117 ms in cellular settings.

There are 20 webpages from Canadian website listed Alexa [3]. Because of widespread use of smartphones and tablets, instead of mobile version the desktop version of these website was used. The chosen webpages were from various categories such as sports, news, business etc.

In the measurements, the page load time (PLT) is used as the indicator of performance of user-perceived. The PLT is the time taken from requesting the initial page to downloaded and processed all associated objects of that page. In this proxy-based architecture the page load time consists of the following components:

• Requesting time from the remote proxy to a page.

• Loading time of a page for remote proxy's web engine.

• Receiving time of the bundle from remote proxy.

• Downloading time of the missing objects in bundle until a webpage is loaded.

• Time taken in downloading the missing objects in bundle until the webpage is loaded.

B. Results

Experiment shows the temporal changes in webpage structures. Average hit ratio of resource lists of webpages is monitored. The hit ratio, which is associated with the resource list corresponding to the change in the structure of page, is declined. Selected webpages are a combination of dynamic webpages such as news webpages and stable home pages of big companies. After performing five experiments, the resource list of webpages is constructed then same pages are loaded every interval of certain period of time. Since the loading of the webpage for first time, the average hit ratio of the webpages as a function of the time passed, it is shown that the highest amount of hit ratio is achieved during the first interval of time. So it can be observed that the changed page structures over the period of time is relatively low. As a result, by updating its resource list, It should be feasible for the remote proxy to capture the temporary changes in webpages.

V. CONCLUSION

In this paper, we have shown proxy based browsing can significantly reduce energy and latency in cellular networks. This approach is designed to eliminate the initial required round-trip time by using a previously recorded resource list of the webpage to discover referenced objects list in a webpage. We have presented previous technique, an initial which moves the task of downloading objects which are needed to render a web-page to a well-provisioned proxy. We have shown that the change in the website's structure is relatively low within a few hours by using real world websites measurement. Therefore, it is feasible to maintain an updated resource list of the popular websites for proxy-based technique, distinct from existing browsers. Compared to a traditional mobile web-browser, proxy-based reduces OLT by 49.6% and energy consumption by 65%. In the future, we plan to incorporate scheduling in proxy-based. So that, during web browsing it will further reduce the energy consumption on the mobile device.

REFERENCES

[1] R. Draves, J. Padhye, and B. Zill, “Routing in multi-radio, multi-hop wireless mesh networks,” in MobiCom ’04. New York, NY, USA: ACM, 2004.

[2] L. Wang and J. Manner, “Energy-efficient mobile web in a bundle,” *Computer Networks*, vol. 57, no. 17, 2013.

[3] B. D. Higgins, J. Flinn, T. J. Giuli, B. Noble, C. Peplin, and D. Watson, “Informed mobile prefetching,” in *Proc. ACM MobiSys*, 2012.

[4] T. Pering, Y. Agarwal, R. Gupta, and R. Want, “Coolspots: Reducing the power consumption of wireless mobile devices with multiple radio interfaces,” in *ACM MobiSys*, 2006.

[5] N. T. Spring and D. Wetherall, “A protocol-independent technique for eliminating redundant network traffic,” in *SIGCOMM ’00*. New York, NY, USA: ACM, 2000.

[6] D. Lymberopoulos, O. Riva, K. Strauss, A. Mittal, and A. Ntoulas, “Pocketweb: Instant web browsing for mobile devices,” in *Proc. ACM ASPLOS*, 2012.

[7] B. Aggarwal, P. Chitnis, A. Dey, K. Jain, V. Navda, V. N. Padmanabhan, R. Ramjee, A. Schulman, and N. Spring, “Stratus: energy-efficient mo- bile communication using cloud support,” *ACM SIGCOMM Computer Communication Review*, vol. 40, no. 4, 2010.

[8] C. Shepard, A. Rahmati, C. Tossell, L. Zhong, and P. Kortum, "Live- Lab: Measuring Wireless Networks and Smartphone Users in the Field," in *Proc. Workshop on Hot Topics in Measurement & Modeling of Computer Systems*, June 2010.