Time-Shifting Traffic to Improve Utilization in Rural Area Networks

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***Abstract*—In this work, we propose a novel architecture that can be used to optimize the usage of the scarce bandwidth in rural areas of the developing world. The architecture consists of a proxy server that time-delays file uploads to other time periods that the networks is underutilized and a web-server that stores the files and manages their delayed upload.**

I. Summary

Recent studies on Internet connectivity issues in rural areas of the developing world reveal that different regions do not have the same opportunities due to the lack of infrastructure or economic incentives of different telecommunication providers. When connectivity deployment is possible, the usual available networks consist of WiFi networks using satellite or WiMax Internet gateways. However, the provided Internet connectivity faces many problems that contain but are not limited to slow satellite connections with bandwidth range of 128 kbps to 512 kbps, unreliable power sources, unavailable devices, remote management of networks, etc. Despite these problems, Internet connectivity has already changed the lives of rural residents by providing access to health care, distance learning programs, and global and local business opportunities.

In our work, we seek to optimize the usage of the available but scarce bandwidth in these regions. Our work extends the current architecture of the LinkNet network in Macha, Zambia presented in paper [1] that includes a VSAT having a download speed of 128 kbps bursting to 1 Mbps and an upload speed of 64 kbps bursting to 256 kbps. Traffic analysis in [1] shows that the satellite gateway is severely congested during the daylight hours. This leads to a slow and poor Internet browsing experience as well as to many network pathologies such timeouts and long round-trip times. Due to severe network congestion users often experience connection time outs and, thus, they are not able to finish their file transfers.

Considering the aforementioned architecture and this recent research work on rural areas traffic characterization, it is imperative to find the mechanisms in order to time-shift large uploads to other time periods that the network is underutilized and provide more capacity for real-time and interactive traffic. We propose a novel architecture [2] for delaying large file uploads with the goal of improving bandwidth utilization and, thereby, more readily facilitating social networking. Our solution includes a time-delayed upload proxy server that acts as the monitoring component and an Apache server that stores the time-shifted files and manages their delayed upload.

The proxy server monitors user traffic using iptable rules by checking every few seconds the upload traffic of each user. It compares the traffic numbers with the current thresholds and takes a decision whether it will allow the user to continue her upload or it will redirect her to the web service to store the file. The user is notified that the uploaded file will be delivered to its final destination when sufficient capacity is available. The web service is implemented using open technologies such as MySql, Apache, PHP and the Zend Framework. It can support the oAuth protocol to allow secure API authorization, i.e., to let users authorize the application to upload files on their behalf without the need of storing their credentials (username and password).

One challenge of our solution is the ability to determine what a file upload is since using iptable rules the only information we have is the amount of bytes transferred from a specific user in a specific time interval. By using the ratio of the outgoing to incoming traffic for each user and for a specific IP address we are able to overcome this problem and, additionally, we do not consider as a file upload traffic that is bidirectional such as videoconferencing. Our initial limit is extracted using past information from the data traces of the Macha network and is updated on a weekly basis based on ongoing measurements. Another challenge for shifting large uploads is to determine a suitable time to reschedule traffic. We are based these decisions on monitoring the network load. If the usage of the satellite link is not high, then, we are able to transfer saved files in a FIFO manner. Our mechanism estimates the expected upload time based on the file size and the network current transfer rate. If the file transfer exceeds the estimated time plus a safe margin then we assume that the network is congested again and we stop the file transfer. The final piece of our proposed proxy is the mechanism that carefully adjusts the threshold above which file uploads are time-delayed. This mechanism takes into account the network conditions and past network usage information.

The problem we address in this work is important not only because its solution will lead to a better bandwidth usage and enhance network performance and availability, but also because it will enable people from rural areas to highlight their culture and traditions. Moreover, they will be able to use the Internet in a more effective way, have the opportunity to participate in the global economy, and access educational resources.

References

[1] D. L. Johnson, V. Pejovic, E. M. Belding, and G. Van Stam, *Traffic characterization and internet usage in rural Africa.* In WWW '11, Hyberabad, India, March 2011.

[2] D. L. Johnson, V. Pejovic, E. M. Belding, and G. Van Stam, *VillageShare: Facilitating Content Generation and Sharing in Rural Networks.* In ACM DEV, Atlanta, GA, March 2012.