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Angaben zur Veröffentlichung / Publication details:

Petropoulos, George, Andri Lareida, Sergios Soursos, Michael Seufert, Valentin Burger, and Burkhard Stiller. 2015. "WiFi offloading and socially aware prefetching on augmented home routers." In *2015 IEEE 40th Conference on Local Computer Networks (LCN), 26-29 October 2015, Clearwater Beach, FL, USA*, edited by Salil Kanhere, Jens Tölle, and Soumaya Cherkaoul. Piscataway, NJ: IEEE.
https://www.ieeelcn.org/prior/LCN40/lcn40demos/Petropoulos.pdf.

WiFi Offloading and Socially Aware Prefetching on Augmented Home Routers

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***Abstract*—This demonstration shows the RB-HORST prototype running live on real hardware. RB-HORST offers WiFi offloading, video caching, and video prefetching based on social and overlay network predictions. RB-HORST is intended to run on home gateways/routers which are represented in the demo as low power computers. The demo will show the functionality of RB-HORST and how users can interact with the system.**

I. Introduction & Motivation

Mobile devices are a central part of everyday's life, as shown by the average number of hours consumers spend with their smartphones or tablets [1]. Cisco estimated that *mobile video traffic* grew to 55% of the overall mobile traffic by the end of 2014 [2]. Furthermore, *Online Social Networks (OSN)* have also attracted a lot of attention. Ericsson's report [3] states that mobile data traffic from social networking amounts for 15% of the total mobile traffic, and that this percentage will be preserved until 2020, rendering the social networks as the second largest mobile traffic source. Since June 2014, when video uploads were introduced in Facebook, an average of more than 1 billion videos have been viewed every day. On average, more than 50% of people visiting Facebook every day in the US watch at least one video daily and 76% of people in the US using Facebook say they tend to discover the videos they watch on Facebook. One can easily understand that social networks constitute a modern and pervasive way for content dissemination and distribution, while mobile devices are the most common means of consuming such content.

In this context, mechanisms that tackle with the social aspects of content distribution and the mobile limitations of content consumption will address a great percentage of the Internet traffic flows. RB-HORST [4] is one such approach, which allows the placement of content close to the end user such that mobile users can access it with less delay and at higher speeds, which generally results in a higher quality of experience. Moreover, RB-HORST eases mobile data offloading to WiFi by sharing home-based Access Points among trusted friends.

In the next sections, we highlight the key concepts of the RB-HORST mechanism and we outline the scenario and set-up of the envisioned demonstration. For more details on the mechanism, its implementation and some preliminary evaluation results, please refer to the work presented in [4].

II. RB-HORST

The goal of RB-HORST is twofold: i) to allow end users to offload mobile data connections to WiFi access points, exploiting available social information and ii) to bring video content, likely to be consumed based on prediction estimates, closer to the end users. To achieve these goals, RB-HORST allows for the formation of an overlay of *Home Routers (HR)* (acting also as local web cache/proxy), based on the common content that their owners consume. Through this overlay, cached content on some HRs can be transferred to other HRs, whose owners are likely to request it in the near future. To estimate the probability of requesting a specific content, RB-HORST exploits available social information, as well as overlay metrics. In addition to the social-aware content prefetching, information available from social networks is used to enable the socially-aware WiFi roaming. In this case, social information is used to build a network of trusted users and allow for the exchange of WiFi credentials between a local Access Point and a trusted user in his vicinity.

Diving into more design details, RB-HORST performs a number of operations. First of all, it enables the 'federation' of home-gateways/access points through the use of social networks. Each owner of an HR, registers it with Facebook and provides its GPS coordinates (through a web graphical interface). This information becomes available to the Facebook friends of the user. In the same manner, through the social network, a user can learn about the existence of 'friendly' HRs.

Once the HRs are registered, the first goal of RB-HORST can be achieved. When a user carrying a mobile device with the RB-HORST mobile application installed enters the coverage of a 'friendly' HR, he is informed through the app about its existence. Moreover, the app automatically switches from the mobile data network to the WiFi, using the credentials provided, by asking the 'friendly' HR for permission. To achieve this automatic switch, each HR exposes two SSIDs: i) a public and open SSID, named 'HORST', which the mobile app scans for when searching for 'friendly' HRs, and through which the Facebook 'friendship' between the HR owner and the mobile user is confirmed and ii) a private and secure SSID, which the user (through the mobile app) is redirected to once the credentials for the secure SSID are provided by the ‘friendly’ HR.

The second goal of RB-HORST involves the prefetching of content to remote HRs that have high probability to be consumed by their attached (visiting) users. To achieve this, the HR acts as a web cache/proxy for Vimeo content and monitors the Facebook feed of its owner for interesting Vimeo video posts. Once a content, that is considered interesting (according to some popularity and location criteria) is published on the social network, the HR tries to prefetch it before the user actually asks for it. The prefetching involved investigating possible sources of the video content which may reside either in the original content server or in caches of trusted HRs. The selection is based on the number of AS hops: sources closer to the end user’s domain are preferred; local domain, as expected, has the highest priority.

To summarize, RB-HORST improves the QoE of end-users by exploiting available social networking and overlay information so as to prefetch interesting content likely to be consumed and enable socially-aware WiFi roaming.

III. Demonstration

The demonstration of RB-HORST requires a well defined scenario since a certain AS topology is required. First the scenario is presented followed by three show cases, showing the benefits of the RB-HORST approach. Finally, the technical equipment needed to run the demo is detailed.

1) Scenario: The demonstration consists of three show cases, which demonstrate the main aspects of RB-HORST:

- WiFi offloading
- Overlay prediction
- Social Prediction

Figure 1Network topology used in the demo scenario.figure.caption.1 shows the network topology used in the demo. HR A is located in AS1 representing a swiss ISP and HRs B and C are located in AS3 representing a Greek ISP. AS1 and AS3 are access providers that are connected to the Internet via AS2 which represents a transit provider. AS1 and AS2 are connected through AS3 to the Internet where content from CDNs, caches, content providers, and Facebook can be accessed.

2) WiFi offloading: George is visiting Switzerland and is using 3G to browse the Internet with his smart phone. Now he visits Andri who owns a RB-HORST enabled HR. Since Andri and George are friends on Facebook, George is considered trustworthy to connect to Andri’s WiFi and access the Internet. With the Android RB-HORST application, George’s smartphone is connected to his Facebook account and it can authenticate with Andri’s HR using the HORST SSID. Upon a successful authentication the RB-HORST application receives the credentials for the secured SSID, installs them in the phone and connects. George has successfully offloaded his 3G connection to Andri’s WiFi without entering a passphrase or using WPS.

By doing this, George is saving battery power since WiFi radio typically uses less energy than a mobile data connection.

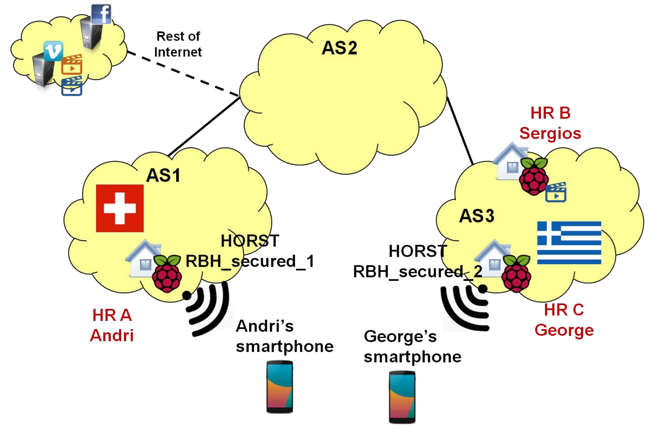

Fig. 1: Network topology used in the demo scenario.

Furthermore, George will save data on his mobile plan which is especially useful when roaming fees can be avoided.

3) Overlay Prediction: George and Andri share common interests and watch many common videos. Hence, their HRs have cached common content, and have become neighbors in the overlay network, in the sense that recently watched videos are predicted as candidates for prefetching.

While George is at Andri’s place, Andri shows him the video ”Italy - A 1 Minute Journey”. The video buffers slowly due to the Internet connection not being very fast. Therefore, the Quality of Experience (QoE) is really low.

At the same time, George’s HR in Greece, executes the overlay prediction and predicts that this video is likely to be watched by George, thus it should be prefetched by Andri’s HR. However, Andri’s HR is more than 1 AS hops away and, therefore, the video will be downloaded from the content provider directly.

Once George is back home, he decides to watch again the video that Andri was showing him. Since the video has been prefetched into the local cache already, there is almost no buffering time and the video plays smoothly. In this case, George has a high QoE.

4) Social Prediction: Both Andri and George are now in their homes. Andri discovers a very good video, ”Brussels in 1 minute”, and decides to post it to Facebook. George’s HR periodically executes the social prediction algorithm, estimates that this video is likely to be watched by George, hence it should be prefetched to local cache. George’s HR checks again for close sources of this video and discovers that Sergios’ HR has it cached as well. Since both HRs are located in the same AS the video is prefetched from Sergios’ HR and no inter-domain traffic is created.

Since they are Facebook friends, the video appears in George’s Facebook News Feed. When George checks Facebook and actually watches the video, he has a high QoE since the video is served from the local cache. Even if his Internet connection is slow or the data center is overloaded, the video playback will be smooth with almost no buffering time.

5) Equipment: To emulate the Internet topology shown in Figure 1Network topology used in the demo scenario.figure.caption.1 a VLAN (Virtual Local Area Network) capable switch and a laptop acting as router will be used. A second computer will be used just for visualization purposes. An Internet connection, providing access to Vimeo.com and Facebook Graph API is required.

The three HRs will be instantiated in the form of three Odroid C1 mini computers, which are extended with a USB dongle providing WiFi so as to act as Access Points with the two SSIDs. To demonstrate the RB-HORST mobile application, perform WiFi roaming and watch some videos, regular Android smartphones will be used where the RB-HORST app will be installed.

The exact demonstration requirements in terms of equipment are provided in the list below:

- Table large enough for three laptops (2 laptops and space for the switch and Odroids)
- HDMI Monitor/Screen (optional)
- Power supply for 2 laptops, 1 switch, 3 Odroids and 1 screen
- Ethernet cable with Internet access (for the switch)
- Poster wall

A slightly different set-up is depicted in Figure 2Hardware set-up used for demonstrating RB-HORST.figure.caption.2. The set-up time of the demonstration environment is expected to take around 30 minutes.

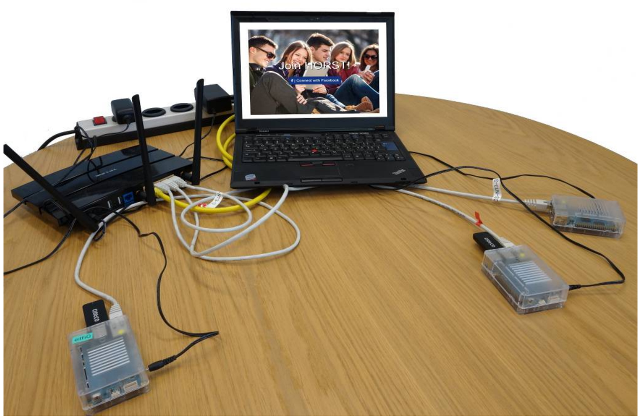

Fig. 2: Hardware set-up used for demonstrating RB-HORST.

IV. Summary and Conclusions

This demonstration has showed how home routers, augmented with RB-HORST software, can improve the user experience by offering caching and prefetching, based on social and overlay network estimates, as well as WiFi roaming and offloading. The source code for all the components of the RB-HORST software is available at https://github.com/smartenit-eu/smartenit.

Acknowledgments

This work was partly funded in the framework of the EU ICT Project SmartenIT (FP7-2012-ICT-317846) and by Deutsche Forschungsgemeinschaft (DFG) under grants HO 4770/1-2 and TR257/31-2. The authors address their thanks to all project partners for their valuable contributions.

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