

OPERETTA: An optimal deployable energy efficient bandwidth aggregation system

Karim Habak, Khaled Harras, Moustafa Youssef

Egypt-Japan University of Science and Technology, Alexandria, EGYPT; Carnegie Mellon University in Qatar, Doha, QATAR

karim.habak@gmail.com

The widespread deployment of varying networking technologies, coupled with the exponential increase in end-user data demand has led to the proliferation of multi-interface enabled devices. To date, these interfaces are mainly utilized independently based on network availability, cost, and user choice. While researchers have focused on simultaneously leveraging these interfaces by aggregating their bandwidths, these solutions however, have faced a steep deployment barrier and only focused on maximizing throughput while overlooking the energy awareness which is critical for mobile devices.

We therefore developed OPERETTA, shown in Figure1, an optimal deployable energy efficient bandwidth aggregation system for mobile users. Our system does not require modifications to applications, legacy servers, network infrastructure, or client kernel. If legacy servers choose to adopt our system, however, OPERETTA dynamically leverages this to achieve higher performance gains. OPERETTA is built as a middle-ware that is responsible for scheduling various connections and/or packets to different interfaces. This middleware estimates application and network interface characteristics and utilizes these estimates to take the most appropriate scheduling decisions. We formulate our scheduling problem as a mixed integer programming problem that has a special structure allowing it to be efficiently solved. This formulation allows users to achieve a desired throughput with minimal energy consumed.

We evaluate OPERETTA via prototype implementation on the Windows OS, as well as via simulation, and compare the results to the optimal achievable throughput and energy consumption. Our results show that, with no changes to the current legacy servers, OPERETTA can achieve up to 150% enhancement in throughput as compared to the current operating systems, with no increase in energy consumption. In addition, with only 25% of the servers being OPERETTA-enabled, the system performance reaches the throughput upper-bound. We ultimately demonstrate that OPERETTA achieves the goals of being optimal, energy-efficient, as well as easily and incrementally deployable.