Active Shared Access Network Congestion Avoidance in Heterogeneous Application-Layer Multicast

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Extended Abstract

Advancing technology enables a growing number of users to access Internet contents on mobile devices like smartphones, tablets, or laptops. This development in turn leads to serious capacity issues in mobile access networks, since bandwidth requirements dramatically increase, while upgrading backbone and access systems is limited and expensive. In the US for instance, 3G service providers already struggle with outages in major cities during rush hours[1], forcing them to offer limited data contracts in favor of flat rates. In accordance with Cisco, the highest fraction of traffic—streaming video—will already account for 66% of overall mobile data traffic by 2015 [1]. Streaming video to a high number of users is a typical example for Internet applications that naturally demand for group communication support. The non-availability of a global service like e. g. IP Multicast leads to alternative approaches like Application-Layer Multicast (ALM) becoming increasingly important, as they offer a flexible and easily deployable solution to the problem. Bringing both aspects (ALM and mobile communications) together raises the question whether the flexibility of ALM protocols can help to reduce the capacity problem in mobile access networks.

In this talk we describe an approach that aims at actively avoiding traffic load congestions in mobile access networks, especially with focus on comparably dense urban environments. We look at a live videostream scenario, where the stream has to be disseminated to a group of mobile receivers by employing a single overlay tree structure connecting them. User devices are assumed to either communicate via 3G exclusively or use alternative communication channels (like e. g. WiFi) in parallel, if available. Most modern mobile devices are typically equipped with these technologies. Furthermore, we assume the existence of a central tracker in the network than can be addressed to obtain the needed traffic load state information (like P4P, for instance). Although non-existent in current networks, the scientific community agrees that there is high need of such a service, but it lacks a consistent standardization [2].

We evaluate the benefit of such a tracker and the related explicit traffic load consideration in ALM by establishing an overlay dissemination tree that trades off traffic load against dissemination delay for all receivers. In a first instance, all receivers communicate via cellular (3G) technology exclusively. To adapt the tree considering the current network situation, a distributed algorithm collects information and refines the tree by eventually switching parents for participating peers. The evaluations show that sacrificing delays to some extent by choosing parents in cells with low traffic load offers high chance of balancing the load in the involved 3G cells in common 3G networks. Unfortunately, using ALM in this scenario only enables to shift traffic between cells and also induces outgoing connections per cell due to the peer-assisted forwarding. To really decrease traffic load in cellular network, a different approach is needed that enhances the single-homed communication. In order to decrease overall traffic load, we further propose the integration of alternative communication technologies into the ALM dissemination tree. Looking at dense urban environments, we describe a distributed mechanism that is able to look up and communicate mutual reachabilities for peers in public WiFi domains, as they are available in high number in nearly every bigger city of the world. These reachabilities are exploited to connect peers inside the local area WiFi domains rather than communication via 3G, shifting part of the traffic from cellular access networks to WiFi networks. The evaluation results are promising and show that the inherent drawbacks of ALM are outweighed by the flexibility of adapting the overlay structure and integrating different communication technologies.

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References

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