PhD proposal in Mobile Computing

Title: Traffic aggregation and network coding to reduce energy consumption while maintaining the quality of service in mobile networks.

Description: With the proliferation of inexpensive end-users heterogeneous mobile devices, a huge increase in demands of multimedia mobile content has been witnessed by the operators. To handle this high traffic volume and the substantial increase in the expected number of clients, the operators act to continuously improve their networks capacity and to rapidly increase their networks connectivity and coverage. However, as an indirect impact on global ICT market, this regular deployment of equipments and multimedia services in everyday-life networks increases significantly the cost of energy consumption for the global ICT-based businesses and strategies. In this context, the proposal aims to participate in reducing the energy footprint of wireless communication networks by using network coding and traffic aggregation.

The goal of proposal is to use network coding [1] in a traffic aggregation context in order to increase the green behavior of multi-hop networks. The main idea is to use distributed algorithms in order to reduce the energy consumption of network nodes. The energy is considered as a resource and the objective is to minimize the use of this resource while satisfying the multimedia application demands. One of the most important algorithms reducing the energy consumption in a telecommunications network is the way to put devices in a sleeping mode [2] when their utility is negligible. In a multi-hop network, a node is useful to route traffic and to connect nodes to each other.

The first objective is to find optimized distributed algorithms that are able to aggregate the traffic of the network to a minimum number of nodes in order to turn off a maximum of devices in the network. On the other side, network coding, which is a very new technique, is able to improve the performance of the network in certain conditions. Those conditions depend on the opportunity that the information meets together (e.g. sharing interfaces, multicast traffic). When the information meets together, the necessary redundancy to decode packets could be constructed for a mutual use and hence reduce the number of retransmissions. The goal of the project is to use the traffic aggregation to first maximize the number of sleeping devices and then to increase the performance of network coding and reduce the number of transmissions. The energy consumption is consequently reduced.

Industrial applications to this proposal are numerous. First relaying and multi-hop routing is going to be more and more used in the network of the Future. Our distributed techniques will maximize the number of turned-off machines to an optimum while guarantying the required quality by connected users. Hence the deployment of such network will be at a minimum energy cost.

Solutions that has to be studies by the candidate is how in a distributed manner, a node could switch off its power while forwarding the traffic of other nodes. It should verify that in the network, it exist a route between source and destination for that flow while respecting the quality the service. This problem is NP-Complete since, the node has to take into account the interferences and conflicts between the radio links. Those conflicts [3] are generally modeled by a conflict graph where the cliques provide the interfering links. The switching off should also take into account the other nodes making the same calculations implying the same conclusion. If two nodes switch off at the same time considering that the other node is going to forward, we could interrupt the connectivity of the network. The candidate should propose a distributed algorithm to desynchronize the switch off of the nodes.

After aggregating the traffic on specific nodes, the candidate should apply network coding to maximize the gain in term of bandwidth. In fact, more the traffic is concentrated; more the degree of the encoded packets could be increased and hence increasing the sharing redundancy. The solution of the candidate should select the optimal random distribution [4, 5] of the degree of the encoded packets. This optimal distribution should minimize the number of retransmissions while reducing the waiting time in intermediate nodes.

The candidate should study the solutions theoretically using graph theory, optimization and network coding theory. He has also to enrich the performance studies by simulation under NS or OPNET. An implementation to provide a prototype is possible if the work is providing interesting results.

References

1. R. Koetter, M. Médard, "An Algebraic Approach to Network Coding", INFOCOM 2002.
2. Khaldoun Al Agha, “Start and Stop for Internet Routers.” Patent FR-INPI 09 58890, 2011.
3. Hakim Badis and Khaldoun Al Agha, “QOLSR, QoS routing for Ad Hoc Wireless Networks Using OLSR,”European Transactions on Telecommunications Journal, Wiley, vol. 16, September/October 2005.
4. Nour Kadi and Khaldoun Al Agha, “Network Coding Based Flooding in Ad-hoc Wireless Networks Under Mobility Conditions,” Annals of Telecommunication, Springer, vol. 65, september-october 2010.
5. A. Kamra, V. Misra, J. Feldman, and D. Rubenstein, “Growth codes: maximizing sensor network data persistence,” in SIGCOMM ’06. New York, NY, USA: ACM, 2006, pp. 255–266.