Computational Capacity of Ad-Hoc Networks

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1 Problem Statement

Wireless Ad-Hoc networks have known considerable interest recently due to their decentralized feature. A wireless Ad-Hoc network is a network where a packet of data information from the transmitting handset (known as a node) is sent through different nodes (by multiple hops) to the final destination (path (2) in figure 1).

This transmission scheme is supposed to increase the flexibility of deploying information infrastructures to cover a given number of users (compared with the case where the information is centralized by a base station, path (2) in figure 1). However, a key issue in data communications with small portable handsets concerns the maximization of battery life (due to energy dissipation in Joules) as well as the efficiency of the network (or data rate in bits/s/Hz). More precisely, considering a given energy at hand for the whole network (total energy of all the handsets), we would like to maximize the number of reliably transmitted bits per joule, rather than the number of bits per second per hertz (spectral efficiency).

In fact, the achievable capacity of ad-hoc networks with battery consumption has not yet been determined and can put at stake the Ad-Hoc network hype. usual studies of Ad-Hoc network based on diversity considerations [1] assume that the information going through a node uses only the transmitted power of that specific node (and not the energy related to the process of information). A recent article of Goldsmith et al. [2] based on energy consumption simulations show that this energy can not be neglected.

In this fundamental research project, we would like to theoretically understand the limitations of Ad-Hoc networks based on physical laws and design an optimal information processing scheme. In fact, all physical systems register and process information [3, 4]. The laws of physics determine the amount of information that a physical system can register (number of bits) as well as the number of elementary logic operations that a system can perform (number of ops). Recent results in physics have shown that the number of elementary logical operations per second that a physical system can perform is limited by the system's energy and that the amount of information that the system can register is limited by its maximum entropy. Based on these

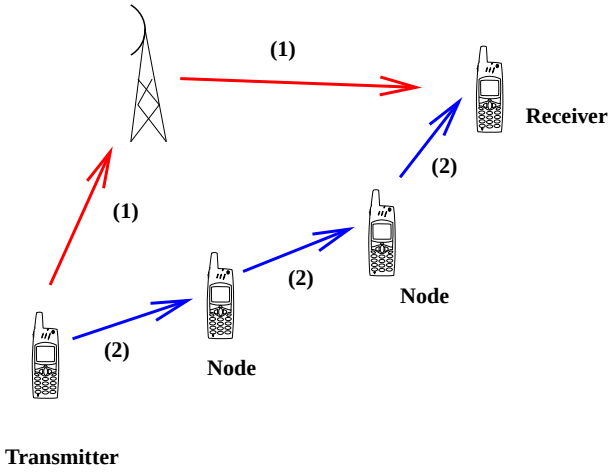

Figure 1: Wireless Ad-Hoc Network

results, Lloyd [5] derived the physical limits of computation of a node. The objective here is to extend this approach to a multi-user wireless network. **Note that this project is to be considered as a prospective mainly theoretical research project and will need a strong commitment**. Therefore, the candidate will be free to propose innovative solutions. The candidate should have a solid background in physics and communications. The internship will start around February/march/april 2007 for a period of four to six months.

2 Contact

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References

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[5] S. Lloyd, *Computational Capacity of the Universe*, Physical Review Letter, vol. 88, n. 83 edition, 2002.