Brief Announcement: A Sample Brief Announcement from 2008 for Other Years

Adrienne Griscti
ACM
New York, NY
griscti@hq.acm.org

Chairs & Organizers
Corporate or Institution
Location, City, Country
lastname@url.org

Chairs & Organizers
Corporate or Institution
Location, City, Country
lastname@url.org

ABSTRACT
Distributed consensus can be achieved on asynchronous communication networks when assisted by quantum mechanics. This contradicts the FLP impossibility result by achieving consensus in the presence of faults.

Categories and Subject Descriptors
C.2.1 [**Computer-Communication Networks**]: Network Architecture and Design – *Wireless communication*; F.2.2 [**Analysis Algorithms and Problem Complexity**]: Nonnumerical Algorithms and Problems – *Computations on discrete structures*.

General Terms: Algorithms, Performance, Design.

Keywords: Wireless Sensor Networks, Multicast, Approximation Algorithm.

1. INTRODUCTION
Distributed computing is necessarily physical and therefore bound by the laws of physics [2], so when proving theoretical impossibility, it makes sense to consider all the possible information processing capabilities of our universe, including quantum mechanics [4]. Recent results have shown that quantum resources enable distributed consensus when no classical algorithm could perform such a task [1] [3]. The most desirable work has been presented in [4], in which the distributed algorithm DMMT (Distributed Min-Max Tree) performs globally optimal. However, its message complexity has been discovered to reach up to the order of $\Omega(n^2)$ recently. This motivates us to design a new distributed algorithm with lower message complexity.

2. A NEW DISTRIBUTED ALGORITHM
We assume that each sensor node has a fixed transmission power p_R to cover all the nodes within the range R. With the evolution of the network, the battery supply ε_v will gradually decrease from the full energy level $\varepsilon_{\max}$ until depletion. In order to avoid the premature failure of new-constructed multicast tree, the sensor nodes with extremely low energy level $\varepsilon_{\min}$ should not be included into the tree as a relay node.

In order to improve the scalability of DMMT [4] with respect to the message overhead, we present a new distributed algorithm DMMT-EQ (DMMT with Energy-supply Quantization) that follows a similar principle but redefines the arc-weigh as follows.

$$w_{vu} \equiv \frac{p_R}{\varepsilon_{\min} + \ell_v \cdot \Delta\varepsilon}, \; \ell_v = \left\lfloor \frac{\varepsilon_v - \varepsilon_{\min}}{\Delta\varepsilon} \right\rfloor, \; \Delta\varepsilon = \frac{\varepsilon_{\max} - \varepsilon_{\min}}{L} \quad (1)$$

Note that there is only L number of values allowed for the arc weight by quantizing the energy supply at each node v to be a series of discrete values $\varepsilon_{\min} + \ell_v \cdot \Delta\varepsilon$ ($0 \le \ell_v \le L$).

The approximation ratio ρ is defined as the ratio of multicast lifetime of the solution obtained by DMMT-EQ to the solution obtained by DMMT. A value closer to one means DMMT-EQ approaching to the optimum. In particular, we can show that DMMT-EQ is a constant-factor approximation algorithm with an approximation ratios bounded by

$$\rho \ge 1 - \frac{h-1}{L + (\ell+1)\cdot(h-1)} \quad (2)$$

in which variable ℓ is an integer within $0 \le \ell \le L$ and the constant number $h = \varepsilon_{\max}/\varepsilon_{\min}$ characterizes the dissimilitude of energy distribution over the network. We also derive that the total number of message c required by DMMT-EQ to construct a multicast tree is bounded by the following linear message complexity $O(m)$.

$$c \le m + 2(L-1)n - (L^2 + L - 2)\,,\; L < n - 1 \quad (3)$$

3. CONCLUSION
In this paper, we proposed a new distributed algorithm DMMT-EQ for the problem of longest-lived multicast communications in WSNs. Further study should be conducted on the enabling power of quantum resources for distributed computing. It seems unlikely that distributed consensus should be the only problem aided by it.

4. REFERENCES
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