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Edgar Chávez (Eds.)

Ad-Hoc, Mobile, and Wireless Networks

4th International Conference, ADHOC-NOW 2005
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Preface

The 4th International Conference on Ad-Hoc Networks and Wireless (ADHOC-NOW 2005) was held October 6–8, 2005 in Cancun, Mexico. Adhoc Now started as a workshop in 2002 and was held at the Fields Institute in Toronto. In 2003, it was held in Montreal, and in 2004 it was held in Vancouver. 2005 was the first year for the conference to move outside of Canada. The purpose of the conference is to create a collaborative forum between mathematicians, computer scientists, and engineers for research in the field of mobile ad hoc and sensor networks.

In 2005, we received over 100 submissions from 22 different countries: Australia, Canada, China, France, Germany, Greece, India, Ireland, Italy, Japan, Korea, Malaysia, Mexico, Nepal, Nigeria, Pakistan, Poland, Spain, Sweden, Tunisia, the UK, and the USA — a true international conference. Of the papers submitted, we selected 27 for presentation at the conference and publication in the proceedings.

We are grateful to our Technical Program, Organizing, and Steering Committees; without their help, expertise, and experience we could not have selected such a fine program. We thank Jorge Urrutia of the Instituto de Matemáticas, Universidad Nacional Autónoma de México, and J.J. Garcia-Luna-Aceves of the Computer Engineering Department, University of California, Santa Cruz for accepting our invitation to speak at the conference. Special thanks are due to the crew from the Facultad de Ciencias Físico-Matemáticas Universidad Michoacana for handling the local arrangements, and to the Mobile Adhoc Research Lab at Arizona State University for handling odd jobs on a moment's notice.

August 2005

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Contributed Papers

Another Look at Dynamic Ad-Hoc Wireless Networks*

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Abstract. The price, performance, and form factors of sensors, processors, storage elements, and radios today are enabling the development of network-supported applications for a wide range of environments, including the monitoring of disruptive phenomena, object tracking, establishment of on-demand network infrastructure for disaster relief or military purposes, and peer-to-peer vehicular or interpersonal networks. However, while in theory ad hoc networks are the ideal vehicle for such applications, the practice today is far from this theory. In this talk, I argue that many of the limitations of ad hoc networks today stem from the fact that the architectures and protocols used for them are in many ways a derivative of the Internet architecture, and describe a research agenda that considers developing ad hoc networks without having to adhere to many of the design choices that, until now, have proven so successful for internetworking of wired networks.

Biography

J.J. Garcia-Luna-Aceves received the B.S. degree in electrical engineering from the Universidad Iberoamericana in Mexico City, Mexico in 1977, and the M.S. and Ph.D. degrees in electrical engineering from the University of Hawaii, Honolulu, HI, in 1980 and 1983, respectively. He holds the Jack Baskin Chair of Computer Engineering at the University of California, Santa Cruz (UCSC). He is also a Principal Scientist at the Palo Alto Research Center (PARC). Prior to joining UCSC in 1993, he was a Center Director at SRI International (SRI) in Menlo Park, California. He has been a Visiting Professor at Sun Laboratories and a Principal of Protocol Design at Nokia.

Dr. Garcia-Luna-Aceves has published a book, more than 290 papers, and seven U.S. patents. He has directed 21 Ph.D. theses and 19 M.S. theses at UCSC over the past 11 years. He is the General Chair for the IEEE SECON 2005 Conference. He has also been Program Co-Chair of ACM MobiHoc 2002 and ACM

* This work was supported in part by the Palo Alto Research Center and by the Baskin Chair of Computer Engineering at University of California, Santa Cruz.

V.R. Sirotiuk and E. Chávez (Eds.): ADHOC-NOW 2005, LNCS 3738, pp. 1–2, 2005.

Mobicom 2000; Chair of the ACM SIG Multimedia; General Chair of ACM Multimedia '93 and ACM SIGCOMM '88; and Program Chair of IEEE MULTIMEDIA '92, ACM SIGCOMM '87, and ACM SIGCOMM '86. He has served in the IEEE Internet Technology Award Committee, the IEEE Richard W. Hamming Medal Committee, and the National Research Council Panel on Digitization and Communications Science of the Army Research Laboratory Technical Assessment Board. He has been on the editorial boards of the IEEE/ACM Transactions on Networking, the Multimedia Systems Journal, and the Journal of High Speed Networks. He received the SRI International Exceptional-Achievement Award in 1985 and 1989, and is a senior member of the IEEE.

Routing in Wireless Networks and Local Solutions for Global Problems

Jorge Urrutia

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Abstract. Let P_n be a set of points. The unit distance graph of P_n is the graph with vertex set P_n, in which two points are connected if their distance is at most one. Unit distance graphs of point sets can be used to model wireless networks in which the elements of P_n represent the location the broadcast stations of our wireless networks. The stations are assumed to broadcast with the same power.

In recent years, it has been proved that many global problems for this type of networks can be solved by means of local algorithms, that is algorithms in which a node needs to communicate only with its neighbours. The first example of this, was the extraction of a planar connected subgraph of a unit distance wireless network, which was then used for a local type routing algorithm. In this talk we will survey several results in this area of research, and present recent results related to approximations of minimum weight spanning trees, snapshots of networks, etc.

Biography

Jorge Urrutia obtained his B.Math. in UNAM, Mexico in 1975, and Ph.D. in Waterloo 1980. His main area of research is Discrete and Computational Geometry. Founder and editor-in-Chief of Computational Geometry, Theory and Applications 1990-2000. In 1998 he joined the Instituto de Matematicas, Universidad Nacional Autonoma de Mexico. Previously he was at the Department of Computer Science at the University of Ottawa.

He has written many papers in Discrete and Computational Geometry and in several areas of Combinatorics. He has delivered numerous plenary talks in conferences in Europe, Asia and the Americas and organized and participated in the organization committees of many conferences. He is well respected in the Mexican Research Community, and is member of the Mexican Sistema Nacional de Investigadores level III.

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Equilibria for Broadcast Range Assignment Games in Ad-Hoc Networks

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Abstract. Ad-hoc networks are an emerging networking technology, in which the nodes form a network with no fixed infrastructure: each node forwards messages to the others by using the wireless links induced by their power levels. Generally, energy-efficient protocols heavily rely on cooperation. In this paper, we analyze from a game-theoretic point of view the problem of performing a broadcast operation from a given station s. We show both theoretical and experimental results on how the existence of (good) Nash equilibria is determined by factors such as the transmission power of the stations or the payment policy that stations can use to enforce their reciprocal cooperation.

1 Introduction

Ad-hoc networks do not need any fixed infrastructure for communication: nodes consist of radio stations that are able to communicate by sending messages with a certain power. This feature is particularly attractive for users since they do not have to rely on a service provider for building/using the network.

Tipically, stations are located in a two-dimensional Euclidean space and are connected by *wireless links* that are induced by their power levels. Each station v is equipped with an *omnidirectional antenna* and, depending on the environmental conditions, a signal transmitted with power P_v can be received by every other station t such that

$$d(v,t)^\alpha \leq \frac{P_v}{\gamma}, \tag{1}$$

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where $d(v,t)$ is the Euclidean distance between v and t, $\alpha \geq 1$ is the distance-power gradient, and $\gamma \geq 1$ is the transmission quality parameter. In an ideal environment (i.e., in empty space) it holds that $\alpha = 2$, but it may vary from 1 to more than 6 depending on the environment conditions at the location of the network (see [16]). According to the previous equation, when a station v transmits with power P_v, it covers an area consisting of all points at distance at most $r_v \geq (P_v/\gamma)^{1/\alpha}$ from v. The value r_v is the *transmission range* of v, i.e., the maximum distance at which station v can transmit in one hop with power P_v. Hence, assigning transmission ranges to the stations is equivalent to decide their transmission powers. In the remaining of this work, we assume $\gamma = 1$, although all of our results easily apply to any constant γ.

The set of all transmission ranges yields a *range assignment* that is a function $r : S \to \mathbb{R}^+$, where S denotes the set of stations and $r(v) = r_v$. We consider *broadcast range assignments*, that is, range assignments which, given a source station $s \in S$, allow this station to transmit to all other stations (via a multi-hop communication). Formally, consider a *transmission graph* $G_r = (S, E_r)$, such that $(v,t) \in E_r$ if and only if $d(v,t) \leq r(v)$. Then r is a broadcast range assignment if G_r contains a directed spanning tree rooted at s.

The *social cost* (or, simply, the cost) of a (broadcast) range assignment is measured as the overall energy that all stations in the network spend to implement these ranges, that is,

$$\mathtt{cost}(r) = \sum_{v \in S} r(v)^\alpha.$$

If ranges are assigned to stations by a central authority, then it is possible to get broadcast range assignments whose cost do not differ to much from the optimum cost (see Subsection 1.2). Implicit in this approach is the assumption that each station will actually transmit with the range specified by the authority. This assumption cannot be take for granted in a (more realistic) scenario in which stations are managed by different (potentially selfish) users. This is indeed the case of ad-hoc networks for which it is fundamental to develop mechanisms that enforce stations cooperation.

In this work, we consider a game-theoretic setting in which each station corresponds to a different player (or agent) of a game named *broadcast range assignment game*. The strategy of each player v is to decide its transmission range $r(v)$ and/or to provide some payment to some other players in order to convince them to transmit with a given range.

The range assignment r derived by the strategies of all players can induce a *benefit* $b_v(r)$ to every station v. The benefit can represent, for example, the interest of station v in guaranteeing the given connectivity, the sum of the payments received/provided from/to the other stations, or a combination of these two things. Since implementing the range $r(v)$ induces a cost of $r(v)^\alpha$, we can define a *utility function*

$$\mu_v(r) = b_v(r) - r(v)^\alpha \tag{2}$$