Wireless Networks

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Abstract

Wireless networks are among the fastest growing areas in networking research. Wireless communication extends the capabilities of fixed networks, to include location-independent information storage, transport, retrieval and processing, and to support mobility of terminals and users. Besides, wireless networks are cheaper and faster to deploy, very important features in rural remote areas, as well as in case of natural disasters. In order to design, realize and maintain high-speed, high performance, cost-effective, and reliable networks, it is of paramount importance to design and evaluate, both analytically and experimentally, new transmission methods as well as new resource allocation algorithms, based on innovative, specific and sophisticated methodologies.

1 Introduction, State of the Art and Future Directions

Mobile networks may accommodate widely ranging data rates; the system bandwidth may be allocated fixed or dynamically according to the user's needs; terminals may be portable (but static when communicating) or mobile (able to communicate while transported as quickly as fast trains or aircrafts can do); terminals may communicate directly or through a base station, and so on. Many other requirements may be listed, which imply different problems to be solved and different technologies to be developed. In any case, mobility is the major, common requirement, whatever technology is used to implement the wireless network.

Wireless networks are usually classified as "infrastructured" (or cellular) and "not infrastructured" (or ad hoc). Cellular networks offer to roaming users access points (often called "base stations") to fixed, wired networks, while ad hoc networks are purely wireless. Obviously, the two types of networks can be interconnected.

In the infrastructured scenario, satellite communication plays a very important role, due to its inner characteristic of broadcasting over wide areas. Communication delay and signal fade are major problems. Technologies such as IEEE 802.11, Bluetooth, or HiperLAN are also very important since they provide very effective responses to requirements of wireless communication over short distances (e.g. in Local Area Networks, Personal Area Networks, Body Area Networks).

When base stations are unavailable to provide connection to mobile terminals, wireless, ad-hoc networks are the response. Ad hoc networks implement a peer-to-peer architecture, where all the network protocols are distributed among the terminal themselves.

1.1 Digital satellite communications

Communication satellites play a major role in telephone transmissions, television and radio distribution, computer communications, maritime navigation, and military command and control. Satellite communication systems differ both from wired and other kinds of wireless links in some peculiar aspects, such as the coverage width, the signal attenuation pattern, the transmission delay, the security issues, and the distance-independent transmission costs. One critical aspect of satellite transmissions is the need of suitable countermeasures to overcome signal degradation due to adverse weather conditions. Specific research topics include:

- fade countermeasure techniques
- multiple access techniques

- dynamic bandwidth assignment algorithms for transmission of multimedia traffic;
- algorithms for the optimisation of the resources for TCP/IP connections;
- packet scheduling techniques

1.2 Wireless ad hoc networks

Mobile, wireless ad-hoc networks are the ultimate response to the needs of self-adapting, rapidly deployable networks, to cope with situations where wired networks or base stations to support mobile terminals are unavailable or unfeasible. Their range of application includes communication in remote or hostile environments, management of emergencies, disaster recovery, and ad-hoc commercial installations. Ad-hoc networks implement a distributed cooperation environment, using a peer-to-peer paradigm. Given the limited range of wireless communication and mobility of nodes, the network connectivity is variable and, to some extent, unpredictable. Major issues are how to implement communication in such a dynamic context and how to guarantee consistency and integrity of the global information. Specific research topics include:

- routing algorithms
- dependable and secure data storage and retrieval
- failure recovery.

1.3 New areas of investigation

The following research activities are standing up as the most promising:

1. UWB Ultra Wide Band
2. MIMO Multiple-Input Multiple-Output
3. Routing protocols for ad-hoc networks
4. Safe and Reliable Data Storage and Retrieval
5. Algorithms for channel assignment
6. Multichannel data broadcasting
7. Hybrid data broadcasting
8. Server allocation in infostations for on-demand communication
9. Tracing and Routing in Wireless Networks.

Each one of them is shortly described below:

UWB Ultra Wide Band
Ultra Wide Band is a new and promising modulation tecnique and transmission method. It uses very short low-power pulses on a very large transmission bandwidth.

Ultrawideband wireless technology was originally conceived as a unique carrierless radio system but changed, on its way from the laboratory to market, into something far less exotic: when the technology is finally standardized, it will be a carrier-based system most likely incorporating frequency hopping and orthogonal frequency-division multiplexing (OFDM). Ultrawideband's new clothes have two tailors. The first is the growing recognition of the technology's commercial potential. The other involves the surprising limitations placed on it by the U.S. Federal Communications Commission (FCC, Washington, D.C.) in February 2002, which made the carrierless approach less attractive.

UWB promises to revolutionize home media networking, taking over such tasks as downloading images from a digital camera to a computer, distributing HDTV signals from a receiver to multiple TV sets around the house, connecting printers to computers, and potentially replacing any electronic signal (not power) cable on the premises.

UWB involves transmitting low-power streams of extremely short pulses on the order of 10-1000 picoseconds. Since such pulses intrinsically occupy a huge amount of bandwidth, their energy is spread thinly over a large swath of the radio frequency spectrum from a few hundred megahertz to several gigahertz. These frequencies are so high that they can be transmitted directly, without first being modulated onto a carrier, as is done with conventional radio systems like AM and FM broadcasts, cellular telephony, and Wi-Fi.

The information is impressed onto the pulse train by varying the amplitude, spacing, or duration of the individual pulses in the train. This is different from the more conventional modulation techniques used in most digital wireless systems, which typically encode information in the form of changes in the phase of the radio wave. But the concept is the same: changes in some parameter of the transmitted signal be it a pulse's position or a sinusoid's phase carry the transmission's information.

Hewlett-Packard, Infineon, Intel, Microsoft, Mitsubishi, Panasonic, Philips, Samsung, and Texas Instruments formed the MultiBand OFDM Alliance in June and have come to dominate the IEEE's ultrawideband (UWB) task group that's writing a UWB standard. Presently at least 20 enterprises supported a proposal by Intel and Texas Instruments that combined frequency hopping jumping around from one part of the allowed spectrum to another at a rate of about three million hops per second with OFDM. The technique uniting these two technologies is called MultiBand OFDM. Open issues in UWB are:

- Interference with local-area networks based on IEEE Standard 802.11a, which operates in the unlicensed 5-GHz region of the spectrum: should be solved by MultiBand OFDM.
- Security, automatic user recognition, authentication, and authorization. Example of an authentication/authorization problem: Imagine two consumer devices such as a video display and a DVD player, both with UWB interfaces. How do you or they determine that it's O.K. for them to talk to each other while they are not to communicate with a similar UWB device a wall thickness away in the next apartment?

MIMO Multiple-Input Multiple-Output

Among emerging radio technologies with the potential to push the frontiers of wireless capacity, Multiple-Input Multiple-Output (MIMO) systems stand out with the promise of many orders of magnitude improvements in spectrum efficiency relative to what is achievable today. MIMO is a modulation technique which uses more than one antenna both for transmission and reception. On a certain bandwidth the density of information is higher than with traditional, single antenna tecniques; theorically it is proportional to the number of used antennas.

The use of multiple-input multiple-output (MIMO) channels has recently attracted considerable interest as an approach that can yield significant capacity gains over conventional smart antenna arrays. This is an extraordinarily bandwidth-efficient approach to wireless communication which takes advantage of the spatial dimension by transmitting and detecting a number of independent co-channel data streams using multiple, essentially co-located, antennas. In the mid 1990's Foschini and his collegues developed the Bell Labs Space-Time (BLAST) architecture that reports achieving spectral efficiencies in the range of 10-20 b/s/Hz for typical configurations. Since then, MIMO systems have attracted a large amount of research interest. The central paradigm is the exploitation, rather than the mitigation, of multipath effects in order to achieve very high spectral efficiencies (bits/sec/Hz), significantly higher than are possible when multipath is viewed as an adversary rather than an ally.

Routing protocols for ad-hoc networks

A Mobile Ad-hoc NETwork (MANET) is a collection of mobile nodes which communicate over

radio and do not need any pre installed communication infrastructure. Mobile nodes communicate with each other using multi-hop wireless links. Each node in the network acts as a router, forwarding data packets for other nodes. Developing a dynamic routing protocol that efficiently find routes between communicating nodes is a central challenge in the design of ad hoc networks. The routing protocol must be able to keep up with the high degree of changes in the network topology due to node mobility and interferences. We briefly describe the state of the art in this field, the principal investigators and some promising research direction. Introduction Wireless ad hoc networks are networks which can be deployed almost anywhere, as they do not need any fixed infrastructure. Units of such networks are often small, mobile, battery powered devices, and communicate with each other through radio signals. As the range of such signals is limited, ad hoc networks are often multihop, and each unit must act as a router for other unit's messages. Although in ad hoc networks no base station is needed, the message delivery between units is much more complicated. The protocol that forwards messages through the network is called the routing protocol. Routing in ad hoc networks should be a distributed algorithm that computes multiple, loop-free routes while keeping the communication overhead to a minimum [1]. It is clear that the existing routing protocols, for wired fixed networks, do not fit the needs of ad hoc networks as they would consume a large amount of the network's bandwidth and of the unit's processing power [2]. Routing protocols can be divided into two main categories: proactive and reactive. Proactive routing protocols [2,3,4] attempt to maintain consistent, up-to-date routing information from each unit to every other unit in the network [5]. Each unit must maintain a routing table where it stores routing information to all other units in the network. To maintain the consistency of such routing tables, units must broadcast their routing tables periodically. When using proactive routing protocols, units can send messages without any delay, because they already have a route to the desired destination. Reactive routing protocols [6,7,8,9] create routes only when a unit desires to send a message. When a unit wants to send a message, it must first find a route to the desired destination, and then it can send the message to the destination. Although reactive routing protocols do not have to maintain up-to-date routing tables, units have a delay on sending their messages. Other categories of routing algorithms can also be found in the literature like: Hybrid routing protocols [10,11] that mix the proactive and the reactive approaches; Geographical routing protocols [12,13] that use location information to route messages; Power Aware routing protocols [14,15] that attempt to reduce the power consumption of the units. In [16] eight different routing protocols has been described, classified (i.e. as reactive or proactive), and compared on the basis of their features. While it is not clear that any particular algorithm or class of algorithm is the best for all scenarios, each protocol has definite advantages and disadvantages, and is well suited for certain situations.

Safe and Reliable Data Storage and Retrieval

A major issue in mobile ad hoc networks is how to implement dependable and secure data storage in mobile ad hoc networks. This is an essential requirement in applications where the mobiles cooperate by sharing information and need to create and access shared files. The system should prevent data losses or corruption due to network disconnections, mobile failures or malicious attacks from untrustworthy mobiles. The file owners should prevent untrustworthy accesses to shared files by secure distribution of access privileges.

The issue of dependable and secude data storage in ad hoc networks is related to issues addressed in recent literature [6-13]. The distributed file systems Petal [6,7] and Coda [8] are based on the client-server paradigm where the servers are assumed secure and trusted. In both cases data availability in ensured by replication, and Petal [6,7] uses encryption to provide data confidentiality. In Coda, mobility of the clients is supported by allowing disconnected mode operations. While connected, the clients generally operate in hoarding mode to upload the data necessary to work when disconnected. Extensions of Coda to cover weak connectivity (i.e. situations where the clients have a slow, although almost permanent, connection to the servers) have been proposed in [9]. If considered for application to mobile, ad hoc networks, the above solutions suffer from the limitation of being conceived for a client server model, assuming secure and reliable servers. This model appears unsuitable to the peer to peer environment of ad hoc networks. Furthermore, Coda

disregards the issue of data confidentiality, and memory and bandwidth requirements of hoarding can hardly be met in the prospected scenario of ad hoc networks. A serverless file system has been proposed in [10]; however it is conceived for systems connected with fast, wired networks, where mobility and disconnections of nodes is not supported. A nice technique for fault-tolerant file server (IDA) based on a peer to peer paradigm has been proposed in [11]. IDA fragments files and disperse fragments by using erasure codes, thus achieving reliability in storage and/or data transmission. However confidentiality issues are not addressed. The above approaches focus mainly on data availability but disregard aspects related to intrusion tolerance, which are deeply investigated in [12,13]. The scheme proposed in [12,13] relies on distributed authentication/authorization servers exploiting majority voting to grant access to the users. The authors use cryptography and data fragmentation and replication in the distributed file server to enforce data availability and confidentiality. This scheme, which has been conceived for wired networks, pays considerable communication overhead to implement user authentication and data fragmentation. This overhead may not be tolerable in wireless ad hoc networks where the communication and computation resources are relatively scarce. An extensive survey on intrusion-tolerant systems can be found in [14]. The issue of dependable distributed storage has also been addressed in the area of digital libraries. In [15,16] a distributed archival intermemory is proposed as a mean to distribute large data sets among a large number of servers. This system partitions the data set among the servers and exploits erasure codes [17] to encode the data. The erasure codes under consideration are systematic and have the property that the original data can still be reconstructed if part of the encoded data is unavailable (for example due to server crashes or network disconnections). However these codes appear unsuitable to provide data confidentiality and do not protect against corruptions caused, for example, by malicious servers or nodes in the data transmission paths. These issues are solved in [18], assuming untrusted communication infrastructure and trusted and secure storage servers. This system uses erasure codes for dependability and data encryption to enforce confidentiality. With different aims, erasure codes provide a mean to speed up downloads in internet applications [19]. Here a file consisting of h data packets is encoded into h+r packets using an erasure code, and the h+r packets are distributed to mirror sites. Since erasure codes allow decoding of encoded data in presence of at least h packets, file readout is completed as soon as h packets are read from the h fastest mirrors.

Open issues in this area are: Data Integrity, Mobility and Energy efficiency, Modular redundancy

Algorithms for channel assignment

Given the dynamic and distributed network environment, algorithms for optimizing resource utilization can be based upon several methodologies. The algorithm can be either on-line (if it has totake decisions without knowing the whole sequence of requests) or off-line [ST85]; centralized or distributed (decisions have to be taken locally by the single network nodes with no knowledge of the global network status); approximate (solutions that differ from the optimum by a bounded value) or heuristic (the solutions are experimentally evaluated on benchmark instances). In addition to optimize resource utilization, the algorithm designer has to force the participants (i.e. servers and users) in the distributed setting to follow the algorithm instead of their own self-interests. Indeed, in an eterogeneous setting such as Internet, the resources belong to different persons and organizations, who cannot accept to freely share their resources. Therefore, the algorithm designer has to take into account the server's selfish interests, and has to motivate their owners to correctly cooperate with the algorithm, by means of Algorithmic Mechanism Design techniques.

CHANNEL ASSIGNMENT ALGORITHMS IN RADIO NETWORKS

In order to achieve high performance in wireless networks, the scarce radio spectrum is partitioned into channels and efficient algorithms are needed for assigning channels to the network stations, so as to avoid interferences. The minimum distance s at which the same channel can be reused with no interference is called "reuse distance". Moreover, channels must be separated by a gap inversely proportional to the distance between the two stations. The channel assignment problems can be formulated as suitable variants of graph coloring problems [H80]. Given the reuse distance s and a

separation vector [d(1), d(2), ... , d(s-1)], the problem consists of assigning a color f(x) to each node x of the graph such that the gap between f(y) and f(x) is at least d(i) whenever dist(x,y) = i and the largest used color is minimized. This problem is computationally intractable (NP-hard). The cases with small reuse distance (up to 3) and particular separation vectors have been extensively studied in [M87], [CP87], and [GY92]. Efficient heuristics based on several techniques (greedy, local search, and saturation degree) have been proposed [R99, BBB99]. Some polynomial time algorithms finding optimum solutions have been presented for particular networks with regular topology [BPT03, BPR03]. In the case of "mobile cellular networks", each node (cell) x requires m(x) colors (channels). In this way, the separation vector becomes [d(0), d(1), ... , d(s-1)] and the coloring function f assigns m(x) colors to each node x, suchthat the gap between two colors assigned to the same node is at least d(0) [KN96]. Since the problem is NP-hard, several heuristics have been proposed, based on simulated annealing, neural networks, genetic algorithms, taboo search, greedy, quadratic assignment, integer linear programming, branch & bound, ant colony systems, etc. [BBC01, R99, MC00, MC01, SHT98, WR97].

SCHEDULING ALGORITHMS FOR DATA DIFFUSION

In a scheduling problem, servers receive sequences of requests for data by users [AM98]. Requests have to be satisfied while pursuing quality of service goals that can in general be expressed as optimization functions of time and bandwidth [BM00, KPV00]. In a system "on-demand", users explicitly require data to servers (e.g. web pages required over phone lines) and then receive the required data "by diffusion" (e.g. the web pages are broadcast via satellite). In a system "by diffusion" servers continuously transit data selections over one or mode radio channels, and users listen to the channel waiting for the desired data. This class of problems can be modelled as scheduling problems: given a set of jobs (that correspond to the users' requests) the goal is to find a scheduling of the jobs released over time on a set of parallel machines (that correspond to the servers) with additional constraints and/or objectives that model the specific considered problem [PS02, BPRG03]. A crucial aspect concerns the amount of knowledge the algorithm has about the input sequence: off-line or on-line. Another important aspect is whether preemption is allowed or not (i.e. whether a job can be interrupted before its completion and its schedule resumed later). Most problems generalize computationally hard scheduling problems that have been studied for decades with no positive results. Therefore, such problems have to be faced by means of approximation or heuristic techniques. Moreover, algorithmic mechanism design techniques seem suitable when modelling systems in whichpayments are involved for data providing.

Multichannel data broadcasting

Broadcast is an efficient and scalable way of transmitting data to an unlimited number of clients that are listening to a channel. Cyclically broadcasting data over the channel is a basic scheduling technique, which is known as *flat* scheduling. When multiple channels are available, a data allocation technique is needed to assign data to channels. Partitioning data among channels in an unbalanced way, depending on data popularities, is an allocation technique known as *skewed* allocation. In this paper, the problem of data broadcasting over multiple channels is considered assuming skewed data allocation to channels and flat data scheduling per channel, with the objective of minimizing the average waiting time of the clients. Several algorithms, based on dynamic programming, are presented which provide optimal solutions for N data items and K channels. Specifically, for data items with uniform lengths, an $O(NK \log N)$ time algorithm is proposed, which improves over the previously known $O(N^2K)$ time algorithm. When $K \leq 4$, faster $O(N)$ time algorithms are exhibited. Moreover, for data items with non-uniform lengths, it is shown that the problem is NP-hard when $K = 2$, and *strong* NP-hard for arbitrary K. In the former case, a pseudo-polynomial algorithm is discussed, whose time is $O(NZ)$ where Z is the sum of the data lengths. In the latter case, two algorithms are devised with time exponential in the maximum data length.

Hybrid data broadcasting

It is believed that broadcast is an efficient way to transmit data in an asymmetric communication system. Most of the previous work focused on either pull-based or push-based scheduling. However,

for systems with a very large number of data items, none of these schemes is efficient individually. We propose a novel hybrid scheduling algorithm which uses both pull- and push-based schemes. In our approach, data items are divided, by a suitable *cut-off point*, into two disjoint sets: one consisting of *more-popular* items and the other of *less-popular* items. The items in the former set are broadcast by a push-based schedule, while those in the latter set by a pull-based schedule. A cut-off point is said to be optimal when it minimizes the expected access time in the system. The optimal cut-off point is derived analytically and validated by simulation experiments. Results show that the proposed hybrid push- and pull-based scheduling performs always better than a pure push-based scheduling and improves on the expected access time of an existing hybrid scheduling scheme.

Server allocation in infostations for on-demand communication
The Server Allocation with Bounded Simultaneous Requests problem arises in infostations, where mobile users going through the coverage area require immediate high-bit rate communications such as web surfing, file transferring, voice messaging, email and fax. Given a set of service requests, each characterized by a temporal interval and a category, an integer k, and an integer h_c for each category c, the problem consists in assigning a server to each request in such a way that at most k mutually simultaneous requests are assigned to the same server at the same time, out of which at most h_c are of category c, and the minimum number of servers is used. Since this problem is computationally intractable, a 2-approximation on-line algorithm is exhibited which asymptotically gives a $\left(2 - \frac{h}{k}\right)$-approximation, where $h = min\{h_c\}$. Generalizations of the problem are considered, where each request r is also characterized by a bandwidth rate w_r, and the sum of the bandwidth rates of the simultaneous requests assigned to the same server at the same time is bounded, and where each request is characterized also by a gender bandwidth. Such generalizations contain Bin-Packing and Multiprocessor Task Scheduling as special cases, and they admit on-line algorithms providing constant approximations.

Tracing and Routing in Wireless Networks
An important issue in wireless networks is the design and analysis of strategies for tracking mobile users. Several strategies have been proposed that aim at balancing the cost of updating the user position and the cost of locating a mobile user. The recently proposed reporting center strategy partitions the cellular network into reporting and non-reporting cells, and associates with each reporting cell aset of non-reporting cells, called its vicinity. The users report their position only when they visit a reporting cell. When a call arrives, the user is searched for only in the vicinity of the last visited reporting center. For a given constant Z, the reporting center problem asks for a set of reporting cells of minimum cardinality such that each selected cell has a vicinity of size at most Z so that the update cost is minimized and the locating cost is bounded by Z. The problem was shown to be NP-hard for arbitrary graphs and $Z \geq 2$. The main contribution of this work is to propose algorithms to optimally solve the reporting center problem for vicinity 2 on interval graphs and for arbitrary vicinity on proper interval graphs.

1.4 Future Directions

1&2 - UWB&MIMO
Practical usages of the techniques will involve study of the MAC (medium access control) level protocols that exploit the characteristics of this new transmission technologies.

3- Routing protocols for ad-hoc networks
here are several issues not yet solved in the area of routing. We still lack a good technique to evaluate different routing algorithms, thus more work in the area of simulators and on models of wireless medium transmission and channel access is required. Moreover, simulative experiments give approximate results, thus good analytical models and techniques are required to analyze different routing algorithms. Efficient and scalable integration of fixed and wireless networks are another important research direction for wireless networking. Formal verification of protocols and algorithms is another important topic. Development of a standard routing algorithm for wireless

sensor networks, where nodes are small, and with limited power and memory, is another difficult topic. The possibilities are tremendous, as evidenced by the current level of interest within research organizations around the world. New technical workshops about ad hoc networks are organized every year, with specializations into security, telematics, and improvements in national wireless access, among others. For instance, the Mobile Ad hoc Networking and Computing (MobiHoc) Symposium has evolved into a multinational event with dozens of speakers and hundreds of people in attendance.

2 Placement of ISTI

The Wireless Networks Laboratory conducts fundamental and applied research covering mobile and wireless communication networks, broadband satellite networks, and integration of communication systems, supported by government and industrial grants. It is also involved in educational and scholar activities, involving graduate and undergraduate students.

2.1 Expertise on Digital satellite communications

Experience of members of this laboratory in satellite communication spans more than twenty years. Research in this area was started in 1979, with the development of the first European network via satellite links.

2.2 Expertise on Wireless ad-hoc networks

The involvement in wireless, ad-hoc network research is quite recent. Members of the Laboratory involved in this research bring a general expertise in algorithms and have been active in fault-tolerance and diagnosis of large-scale parallel systems.

2.3 The challenge of new technologies

The Wireless Networks Laboratory has the knowledge required to start new studies on MAC protocols which can take advantage of new communication technologies like UWB and MIMO. Experiments and practical tests on prototypes could be conducted in collaboration with the Information Engineering department of Pisa University.

2.4 Channel Assignment Algorithms in Radio Networks

The channel assignment problems have been modelled as node coloring problems on undirected graphs. The Wireless Networks Laboratory wants to continue studying channel assignment problems for wireless networks. In particular, we want to devise new optimal and approximate algorithms for further regular topologies, considering more complex separation vectors. Moreover, for more general classes of graphs (e.g. bipartite or planar graphs), where the problem is known to be NP-hard, new approximate solutions can be devised for vectors $[1, 1, \ldots, 1]$ and $[d(1), 1, \ldots, 1]$. Furthermore, we want to generalize our results to the case where each station requires more than one single channel (multicoloring version), each station can specify a subset of "preferred" channels, and to the case where, instead of verifying all the channel requests per station minimizing the overall number of used channels, one may try to maximize the satisfied channel requests per station while using a predefined number of channels. As for the heuristics on arbitrary graphs, we want to devise new lower bounds using the analogy between the channel assignment and the quadratic assignment. Such new lower bounds will be similar to those provided by Gilmore-Lawler and Christofides-Gerrad for the quadratic assignment. These lower bounds will be used within branch & bound or partial enumerative algorithms. In the branch & bound, we want to adopt different branch strategies, such as a parallel expansion strategy in place of the usual depth first strategy.

2.5 Scheduling Algorithms for Data Diffusion

The Wireless Networks Laboratory wants to continue studying scheduling algorithms for data diffusion, so as to refine, for the case of single channel, the hybrid algorithm with the goal of eliminating the anomaly that data required very often by few users (which have to be disseminated) are confused with data required by many users (which have to be broadcast). Moreover, we want to take into account data with variable transmission time, allowing preemption of a broadcast under certain conditions. Finally, we want to extend such a model to multiple radio channels. As for the infostations, we want to consider clusters of infostations. In such a cluster, each infostation still has a limite coverage, but various infostations are regularly scatterded so that the mobile user could know when and where he will encounter the next infostation and thus could estimate which infostation along his route is more appropriate to satisfy his request.

Collaborators:
Imrich Chalmtac (http://www.utdallas.edu/ chlamtac/)
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Amotz Bar-Noy (http://www.sci.brooklyn.cuny.edu/ amotz/)

3 Principal Conferences, Journals and Investigators

People:
C.E. Perkins (Nokia Research Center)
D.B. Johnson (Rice University)
M. Gerla (UCLA Computer Science Department)
S.K.S. Gupta (Computer Science Department of Arizona State University)
E. Royer and C. Toh (Department of Computer Science, University of California)

Groups and Sites:

1- About UWB:
http://www.ultrawidebandplanet.com/
IEEE 802.15.3a UWB task group : http://www.ieee802.org/15/pub/TG3a.html
The Ultra Wideband Working Group: http://www.uwb.org/

2- About MIMO:
BLAST: Bell Labs Layered Space-Time - An Architecture for Realizing Very High Data Rates over Fading Wireless Channels
http://www1.bell-labs.com/project/blast/

5,6,7- About ...:
ACM Data Communication SIGCOMM (http://www.acm.org/sigcomm/)

> The ACM Special Interest Group on Data Communication provides a forum for computing professionals involved in the vital field of data communication. The SIG focuses on network architecture, network protocols, distributed systems and publications. SIGCOMM co-sponsors with the IEEE, the ACM/IEEE Transactions on Networking journal. SIGCOMM also co-sponsors many conferences and publishes the quarterly newsletter Computer Communication Review (CCR), which includes SIGCOMM's annual conference proceedings. CCR publishes five times yearly.

ACM Mobility of Systems, Users, Data and Computing SIGMOBILE (http://www.sigmobile.org/)

> The purpose of ACM SIGMOBILE is to promote research and development by bringing together researchers and practitioners and fostering interest in the mobility of

systems, users, data, and computing. SIGMOBILE addresses the above spectrum of topics, sharing one common theme - mobility. The group's technical scope reflects the emerging symbiosis of portable computers and wireless networks, addressing the convergence of mobility, computing and information organization, its access, services, management and applications. SIGMOBILE places emphasis on the various areas of nomadic computing, data management, related technologies, and mobile user services, alongside more "classical" topics in wireless and mobile networking. The SIGMOBILE Newsletter, MC2R is published on a quarterly basis. SIGMOBILE offers its members a Member Plus Package.

ACM Management of Data SIGMOD (http://www.acm.org/sigmod/)

The ACM Special Interest Group on Management of Data investigates the development and application of database technology on a full range of computer organizations. The scope of interests and members is wide with an almost equal mix of people from industry and from academia. SIGMOD sponsors an annual conference that is regarded as one of the most important in the field, particularly for practitioners. Similarly, the quarterly newsletter SIGMOD Record is a valuable resource for state-of-the-art information and includes the annual conference proceedings.

ACM Hypertext, Hypermedia and Web SIGWEB (http://www.acm.org/sigweb/)

Formerly known as SIGLINK, the ACM Special Interest Group on Hypertext, Hypermedia and Web addresses the concerns of the multi-disciplinary field of hypertext and hypermedia. It provides a forum for the promotion, dissemination, and exchange of ideas concerning research technologies and applications among scientists, systems, designers, and end users. The SIGWEB Newsletter provides information on the design, use and evaluation of hypertext and hypermedia systems and publishes three times a year.

3.1 Main International Journals

- IEEE Transactions on Computers
- IEEE Transactions on Mobile Computing
- IEEE/ACM Transactions on Networking
- IEEE Transactions on Parallel and Distributed Systems
- ACM MObile NETworks and applications (MONET)

1- About UWB:

- IEEE Microwave
- IEEE Spectrum

2- About MIMO:

- IEEE Transactions on Communications
- IEEE Journal on Selected Areas in Communication

3- About Routing protocols for ad-hoc networks:

- EEE TPDS - IEEE Transactions on Parallel and Distributed Systems
- IEEE IT - IEEE Transactions on Information Theory

- IEEE SMC - IEEE Transactions on System, Man and Cybernetics
- JoA - Journal of Algorithms
- JPDC - Journal of Parallel and Distributed Computing
- CC - Computer Communications
- TCS - Theoretical Computer Science

4 About Safe and Reliable Data Storage and Retrieval:

- IEEE Transactions on Dependable and Secure Computing
- ACM Transactions on Infomation and System Security

5,6,7- About ...:

- IEEE Trans. on Vehicular technology
- IEEE Trans. on Broadcasting
- Wireless Networks - The Journal of Mobile Communication, Computation and Information
- Wireless Personal Communications - An International Journal
- International Journal of Wireless Information Networks
- Journal of Parallel and Distributed Computing
- http://www.sigmobile.org/pubs/mc2r/index.html

3.2 Main International Conferences

- SPECTS International Symposium on Performance Evaluation of Computer and Telecommunication Systems
- International Conference "Workshop on Nomadic Computing"

1- About UWB:

- International Conference on Ultra-Wideband
- Short-Pulse Electromagnetic International Conference on Ultra-Wideband

2- About MIMO:

- Wireless Personal Multimedia Communications
- IEEE VTC
- IEEE Globecom

3- About Routing protocols for ad-hoc networks:

- PODC - ACM Symposium on Principles of Distributed Computing
- MobiHoc - ACM Symposium on Mobile Ad Hoc Networking and Computing
- EC03 - 4th ACM Conference on Electronic Commerce
- MOBICOM - ACM Conference on Mobile Computing and Networking
- DSN - IEEE International Conference on Dependable Systems and Networks

- TCS - IFIP International Conference on Theoretical Computer Science
- POMC - ACM Workshop on Principles of Mobile Computing
- MSWi - ACM International Workshop on Modeling, Analysis and Simulation of Wireless and Mobile Systems

4 About Safe and Reliable Data Storage and Retrieval:

- IEEE Dependable Systems and Networks (DSN)
- ACM Symposium on Operating Systems Principles (SOSP)

5,6,7- About ...:

- MOBICOM http://www.sigmobile.org/mobicom/
- ACM SIGCOMM http://www.acm.org/sigcomm/sigcomm2004/
- INFOCOM http://www.ieee-infocom.org/
- IEEE Int'l Conference on Communication (ICC) http://www.icc2004.org/
- ACM Mobile Data Management, MDM http://www.cs.duke.edu/mdm2004/AdvanceProgram.html
- IPDPS http://www.ipdps.org
- International Workshop on Algorithms for Wireless, Mobile, Ad Hoc and Sensor Networks (WMAN), in conjunction with IEEE-IPDPS2004 http://ranger.uta.edu/ kumar/ipdpswman.html
- 1st IEEE International Conference on Mobile Ad-hoc and Sensor Systems (MASS) http://www.ececs.uc.edu/ cdmc/mass/
- Workshop on High Performance Switching and Routing (HPSR) http://hpsr2004.asu.edu

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5 Bibliography

1- About UWB:

"Ultra-Wideband Wireless Systems," by G. Roberto Aiello and Gerald D. Rogerson, IEEE Microwave, June 2003, pp. 36-47.

"Ultra-Wideband, Short-Pulse Electromagnetics by Short-Pulse Electromagnet", International Conference on Ultra-Wideband, Lawrence Carin, Leopold B. Felsen (Editor), Henry L. Bertoni

"Ultra-Wideband, Short-Pulse Electromagnetics 2", Proceedings of the Second International Conference Held at Weber Research Institute, Polytechnic Unit, by Lawrence Carin, Leopold B. Felsen (Editor)

"Ultra-Wideband, Short-Pulse Electromagnetics 3", by Carl E. Baum (Editor), Lawrence Carin (Editor), Alexander P. Stone (Editor), Short-Pulse Electromagneti International Conference on Ultra-Wideband

"Ultra-Wideband Short-Pulse Electromagnetics 4", by Ehud Heyman (Editor), Benjamin Mandelbaum (Editor), Joseph Shiloh (Editor), Short-Pulse Electromagneti International Conference on Ultra-Wideband

2- About MIMO:

Shafi, M.; Gesbert, D.; Da-shan Shiu; Smith, P.J.; Tranter, W.H.; "Guest editorial: MIMO systems and applications. 1", Selected Areas in Communications, IEEE Journal on , Volume: 21 Issue: 3 , April 2003 Page(s): 277 -280

Shafi, M.; Gesbert, D.; Da-shan Shiu; Smith, P.J.; Tranter, W.H.; "Guest editorial MIMO systems and applications. II", Selected Areas in Communications, IEEE Journal on , Volume: 21 Issue: 5 , June 2003 Page(s): 681 -683

G. J. Foschini and M. J.Gans, On the limits of wireless communications in a fading environment when using multiple antennas, Wireless Personal Commun., vol. 6, pp. 315-335, 1998.

Foschini, G.J.; Golden, G.D.; Valenzuela, R.A.; Wolniansky, P.W.; "Simplified processing for high spectral efficiency wireless communication employing multi-element arrays", Selected Areas in Communications, IEEE Journal on, Vol.17, Iss.11, Nov 1999 Pages:1841-1852

Beach, M.A.; McNamara, D.P.; Fletcher, P.N.; Karlsson, P.; "MIMO-a solution for advanced wireless access?", Antennas and Propagation, 2001. Eleventh International Conference on (IEE Conf. Publ. No. 480) , Volume: 1 , 17-20 April 2001 Page(s): 231 -235 vol.1

Gesbert, D.; Shafi, M.; Da-shan Shiu; Smith, P.J.; Naguib, A.; "From theory to practice: an overview of MIMO space-time coded wireless systems", Selected Areas in Communications, IEEE Journal on , Volume: 21 Issue: 3 , April 2003 Page(s): 281 -302

3- About Routing protocols for ad-hoc networks:

1 S. Basagni, I. Chlamtac, V.R. Syrotiuk, and B.A. Woodward, "A Distance Routing Effect Algorithm for Mobility (DREAM)", Proc. ACM/IEEE MOBICOM 98, pp. 76-84, 1998.

2 C.E. Perkins, and P. Bhagwat, "Highly Dynamic Destination-Sequenced Distance-Vector Routing (DSDV) for Mobile Computers", Proc. ACM SIGCOMM 94, pp. 234-244, 1994.

3 S. Murthy, and J.J. Garcia-Luna-Aceves, "An Efficient Routing Protocol for Wireless Networks", ACM/Baltzer Mobile Networks and Applications, special issue on Routing in Mobile Communications Networks, vol. 1, no. 2, pp. 183-197, 1996.

4 C.R. Lin, and J.S. Liu, "QoS Routing in Wireless Ad Hoc Networks", IEEE Journal on Selected Areas in Communications, special issue on Wireless Ad Hoc Networks, vol. 17, no. 8, pp. 1426-1438, 1999.

5 C.K. Toh, Ad Hoc Mobile Wireless Networks - Protocols and Systems, Prentice Hall PTR, 2002.

6 D.A. Maltz, J. Broch, J. Jetcheva, and D.B. Johnson, "The Effects of On-Demand Behavior in Routing Protocols for Multihop Wireless Ad Hoc Networks, IEEE Journal on Selected Areas in Communications, special issue on Wireless Ad Hoc Networks, vol. 17, no. 8, pp. 1439-1453, 1999.

7 D.B. Johnson, and D.A. Maltz, "Dynamic Source Routing in Ad Hoc Wireless Netwoks" Mobile Computing Chapter 5, Kluwer Academic Press, pp. 153-181, 1996.

8 V.D. Park, and D.S. Corson, "A Highly Adaptive Distributed Routing Algorithm for Mobile Wireless Networks", Proc. IEEE INFOCOM 97, pp. 1405-1413, 1997.

9 C.E. Perkins, and E.M. Royer, "Ad-hoc On-Demand Distance Vector (AODV) Routing", Proc. IEEE WMCSA'99, pp. 90-100, 1999.

10 Z.J. Haas, and M.R. Pearlman, "The Performance of Query Control Schemes for the Zone Routing Protocol", IEEE/ACM Transactions on Networking, vol. 09, no. 4, pp. 427-438, 2001.

11 V. Ramasubramanian, Z.J. Haas, and E.G. Sirer, "SHARP: A Hybrid Adaptive Routing Protocol for Mobile Ad Hoc Networks", Proc. ACM MobiHoc 03, pp. 303-314, 2003.

12 Y.B. Ko, and N.H. Vaidya, "Location-Aided Routing (LAR) in mobile ad hoc networks", Wireless Networks, vol. 06, pp. 307-321, 2000.

13 A. Rao, S. Ratnasamy, C. Papadimitriou, A. Shenker, and I. Stoica, "Geographical Routing without Location Information", Proc. ACM Mobicom 03, pp. 96-108, 2003.

14 Y.E. Sagduyu, and A. Ephremides, "Energy-Efficient Collisions Resolution in Wireless Ad-Hoc Networks", Proc. IEEE INFOCOM 03, 2003.

15 Q. Li, J. Aslam, and D. Rus, "Online Power-aware Routing in Wireless Ad-hoc Networks", ACM SIGMOBILE 01, pp. 97-107, 2001.

16 E. Royer and C. Toh, "A Review of Current Routing Protocols for Ad-Hoc Mobile Wireless Networks", IEEE Personal Communications, Apr. 1999.

4 About Safe and Reliable Data Storage and Retrieval:

Rajiv Tewari, Peter Grillo, "Data Management for Mobile Computing on the Internet", ACM Conference on Computer Science, pp. 246-252, 1995.

Evaggelia Pitoura, George Samaras "Data Management for Mobile Computing", Kluwer Academic Publishers, Norwell, MA, 1997

Jos Merseguer, Javier Campos and Eduardo Mena, "Analysing internet software retrieval systems: modeling and performance comparison", Wireless Networks, pp. 223-238, 2003.

5- About Algorithms for channel assignment

K. J. Maly, E. C. Foudriat, R. Mukkamala, C. M. Overstreet, and D. Game. Dynamic Allocation of Bandwidth in Multichannel Metropolitan Area Network. Computer Networks and ISDN Systems, 25:203–223, 1992.

Zhenyu Tang; Garcia-Luna-Aceves, J.J. Collision-avoidance transmission scheduling for ad-hoc networks Communications, 2000. ICC 2000. 2000 IEEE International Conference on , Volume: 3 , 18-22 June 2000 Page(s): 1788 -1794 vol.3

CP87 I. Chlamtac & S.S. Pinter, "Distributed nodes organization algorithm for channel access in multihop dynamic radio networks", IEEE Trans. on Comp., 36 (1987) 728-737.

GY92 J.R. Griggs & R.K. Yeh, "Labelling graphs with a condition at distance 2", SIAM J. on Discr. Math., 5 (1992) 586-595.

H80 W.K. Hale, "Frequency assignment: theory and applications", Proc. IEEE, 68 (1980).

KN96 I. Katzela & M. Naghshineh, "Channel assignment schemes for cellular mobile telecommunication systems: a comprehensive survey", IEEE Personal Comm., 1996, 10-31.

M87 T. Makansi, "Transmitted oriented code assignment for multihop packet radio", IEEE Trans. Comm., 35 (1987) 1379-1382.

R99 S. Ramanathan, "A unified framework and algorithm for channel assignment in wireless networks", WiNet 5 (1999) 81-94.

SHT98 D.H. Smith, S. Hurley, & S.U. Thiel, "Improving heuristics for the frequency assignment problem", EJOR 107 (1998) 76-86.

WR97 W. Wang & C.K. Rushforth, "Local search for channel assignment in cellular mobile networks", DIMACS 35 (1997) 689-709.

BBB99 R. Battiti, A.A. Bertossi, & M.A. Bonuccelli, "Assigning codes in wireless networks: bounds and scaling properties", WiNet 5 (1999) 195-209.

BBC01 R. Battiti, A.A. Bertossi, & D. Cavallaro, "A randomized saturation-degree heuristic for channel assignment in cellular radio networks", IEEE Trans. Vehicular Tech. 2001.

BPT03 A.A. Bertossi, M.C. Pinotti, & R.B. Tan, "Channel Assignment with Separation for Interference Avoidance in Wireless Networks", IEEE Transactions on Parallel and Distributed Systems, February 2003.

MC00 V.Maniezzo, A.Carbonaro, "An ANTS Heuristic for the Frequency Assignment Problem", Future Generation Computer Systems 16, North-Holland/Elsevier, pp. 927 - 935, 2000.

MC01 V.Maniezzo, A.Carbonaro, "Ant Colony Optimization: an overview", Essays and Surveys in Metaheuristics, Kluwer (III Metaheuristic Intl. Conference, Angra dos Reis, Brazil), 2001.

AM98 S. Aacharya, & S. Muthukrishnan, "Scheduling on-demand broadcasts: new metrics and algorithms", ACM/IEEE Inter'l Conf. Mobile Comp. and Netwk., 43 - 54, 1998.

BM00 Y. Bartal, & S. Muthukrishnan, "Minimizing Maximum Response Time in Scheduling Broadcasts", 558-559, SODA, 2000.

KPV00 B. Kalyanasundaram, K. Pruhs, & M. Velauthapillai, "Scheduling broadcasts in wireless networks", ESA, 2000.

BPRG03 A.A. Bertossi, M.C. Pinotti, R. Rizzi & P. Gupta, Allocating Servers in Infostations for Bounded Simultaneous Requests, IEEE Int'l Parallel and Distributed Processing Symposium, April 22-26, 2003, Nice, France.

ST85 D.Sleator, R.E. Tarjan, "Amortized efficiency of list update & paging rules", Comm. ACM, 28, 202-208, 1985.

M00 B. Mukherjee, "WDM Optical Communication Networks: Progress and Challenges", IEEE JSAC, 18, no. 10, 2000.

ZJM00 H. Zang, J.P. Jue, & B. Mukherjee, "A Review of Routing and Wavelength Assignement Approaches for Wavelength-Routed Optical WDM Networks",Opt. Networks, Mag., 1, 2000.

YB98 J. Yoo & S. Banerjee, "Design, Analysis, and Implementation of Wavelength-Routed All-Optical Networks: Routing and Wavelength Assignment Approach," IEEE Comm. Surveys, 1998.

MS00 L. Margara, J. Simon "Wavelength Assignment Problem on All-optical Networks with k Fibres per Link", 27th International Colloquium on Automata, Languages, and Programming (ICALP 2000), Ginevra, Switzerland, 2000, LNCS 1853.

MS01 L. Margara, J. Simon "Decidable Properties of Graphs of All-optical Networks", 28th International Colloquium on Automata, Languages, and Programming (ICALP 2001), Creta, 2001, LNCS.

M01 L. Margara "Wavelength Assignment Problem in All-optical Rings Revisited", 2nd International Workshop on Approximation and Randomized Algorithms in Communication Networks (ARACNE 2001), BRICS, University of Aarhus, Denmark, 2001.

6 - About Multichannel Data Broadcasting:

Chih-Lin Hu; Ming-Syan Chen Adaptive balanced hybrid data delivery for multi-channel data broadcast Communications, 2002. ICC 2002. IEEE International Conference on , Volume: 2 , 28 April-2 May 2002 Page(s): 960 -964 vol.2

7 - About Server allocation in infostations for on-demand communication:

Wu, Z.D. Design and analysis of video-on-demand servers Global Telecommunications Conference, 1998. GLOBECOM 98. The Bridge to Global Integration. IEEE , Volume: 2 , 8-12 Nov. 1998 Page(s): 773 -778 vol.2

Leung, M.Y.Y.; Lui, J.C.S.; Golubchik, L. Use of analytical performance models for system sizing and resource allocation in interactive video-on-demand systems employing data sharing techniques Knowledge and Data Engineering, IEEE Transactions on , Volume: 14 Issue: 3 , May-June 2002 Page(s): 615 -637

Yinqing Zhao; Kuo, C.-C.J. Video-on-demand server system design with random early migration Circuits and Systems, 2003. ISCAS '03. Proceedings of the 2003 International Symposium on , Volume: 2 , 25-28 May 2003 Page(s): II-640 -II-643 vol.2

ISTI Authors (journal papers):

Celandroni Nedo: "Analisys of transient of the datagram traffic for a demand assignment TDMA satellite access scheme", Performance Evaluation, 31, pp. 301-319, 1998.

Celandroni Nedo, Rizzo Santi T. "Detection of Errors Recovered by Decoders for Signal Quality Estimation on Rain-Faded AWGN Satellite Channels", IEEE Transactions on Communications, Vol. 46, N. 4, pp. 446-449, April, 1998.

Celandroni Nedo, Ferro Erina, Potorti' Francesco "A simulation tool to validate and compare satellite TDMA access schemes", Telecommunication Systems, 12 (1999) 1, pp. 21-29.

Maestrini Piero, Sallay Balazs, Santi Paolo "A Comparison-Based Diagnosis Algorithm Tolerating Comparator Faults", IEE Proceedings-Computers and Digital Techniques, No. 4, vol. 146, p. 211, 1999.

R. Battiti, A.A. Bertossi, M.A. Bonuccelli "Assigning codes in wireless networks: bounds and scaling properties", Wireless Networks, vol. 5, no.3 (May 1999), pp. 195-209.

Celandroni Nedo, Ferro Erina, Potorti' Francesco, Antonio Chimienti, Maurizio Lucenteforte, Romualdo Picco "MPEG-2 coded video traces transmitted over a satellite link: scalable and non-scalable solutions in rain fading condition",Multimedia Tools And Applications, Vol. 10, N. 1, pp. 73-97, 2000

Celandroni Nedo, Ferro Erina, Potorti' Francesco, Antonio Chimienti, Maurizio Lucenteforte "Dynamic rate shaping on MPEG-2 video streams for bandwidth saving on a faded satellite channel", European Transactions on Telecommunications (ETT), Vol. II, N.4, July/August 2000, pp. 363-372.

Celandroni Nedo, Potorti' Francesco "Fade countermeasure using signal degradation estimation for demand-assignment satellite systems", Journal of Communications and Networks, Vol. 2, No. 3, pp. 230-238, September 2000.

Krishnamurthi Govind, Chessa, Stefano, Somani Arun "Fast Recovery from Database/Link Failures in Mobile Networks", Computer Communications, No. 5-6, vol. 23, p. 561-574, 2000.

P. Barcaccia, M.A. Bonuccelli, M. Di Ianni "Complexity of minimum length scheduling for precedence constrained messages in distributed systems", IEEE Trans. on Parallel and Distributed Systems, vol. 11, no. 10 (October 2000), pp.1090-1102.

Gregori Enrico, Marcantonio Riccardo, Potorti' Francesco. "GSn: a new service type for integrated services on the Internet". European Transactions on Telecommunications, Vol. 12, No. 1, pp. 3-12, January-February 2001.

Celandroni Nedo, Ferro Erina "A multifrequency TDMA/TDM system for a VSAT terminal network operating in Ka band", Journal of Communications and Networks, Vol. 3, Number 2, June 2001, pp. 132-141.

Chessa Stefano, Maestrini Piero "Correct and Almost Complete Diagnosis of Processors Grids", IEEE Transactions on Computers, No. 10, vol. 50, p. 1095-1102, 2001.

Chessa Stefano, Santi Paolo "Operative Diagnosis of Graph-Based Systems with Multiple Faults", IEEE Transactions on Systems Man and Cybernetics, Part A-Systems and Humans, No. 2, vol. 31, p. 112-119, 2001.

M.A. Bonuccelli, M.C. Cl "Scheduling of Real Time Messages in Optical Broadcast-and-Select Networks", IEEE Trans. on Networking, vol. 9, no. 5 (October 2001), pp. 541-552.

Celandroni Nedo, Ferro Erina, Potorti' Francesco "A multi-level satellite channel allocation algorithm for VBR real-time data", International Journal on Satellite Communications, Vol. 20, Number 1, January-February 2002, pp. 47-61.

Bolla Raffaele, Celandroni Nedo, Davoli Franco, Ferro Erina, Marchese Mario "Bandwidth allocation in a multiservice satellite network based on long-term weather forecast scenarios", Computer Communications Journal, N. 25, July 2002, pp. 1037-1046.

Ferro Erina, Franck Laurent, Maral Gerard "Packet-oriented service delivery via satellites", IEEE Global Communications Newsletter in IEEE Communications Magazine. I part: September 2002, Vol. 40, No 9, pp. 2-3; II part: October 2002, Vol. 40, N. 10, pp.2-4.

Santi Paolo, Chessa Stefano "Crash Faults Identification in Wireless Sensor Networks", Computer Communications No. 14, vol. 25, p. 1273-1282, 2002.

Caruso Antonio, Chessa Stefano, Maestrini Piero, Santi Paolo "Diagnosability of Regular Systems", JOURNAL OF ALGORITHMS, vol. 45, No 2, , p. 126-143, 2002.

Caruso Antonio, Chessa Stefano, Maestrini Piero, Santi Paolo "Evaluation of a Diagnosis Algorithm for Regular Structures", IEEE Transaction on Computers, No. 7, vol. 51, p. 850-865, 2002.

Chessa Stefano, Maestrini Piero, Sallay Balazs, Tripiccione Raffaele, Errico Walter, Schifano Fabio "Self-Diagnostic Tools of the APEmille Parallel Machine", IEE Proceedings-Computers and Digital Techniques, vol.149, no.6, pp.273-281. 2002.

V. Auletta, S.K. Das, A. De Vivo, M.C. Pinotti,V. Scarano, "Optimal Tree Access by Elementary and Composite Templates in Parallel Memory Systems", IEEE Transactions on Parallel and Distributed Systems, Vol. 13, No. 4, 2002, pp. 399-412.

S. Olariu, M.C. Pinotti, L. Wilson "Greedy Algorithms for Tracking Mobile Users in Special Mobility Graphs", Discrete Applied Mathematics, Vol 117/1-3, 2002, pp. 215-227.

A.A. Bertossi and M.C. Pinotti "Mappings for Conflict-Free Access of Paths in Bidimensional Arrays, Circular Lists, and Complete Trees", Journal of Parallel and Distributed Computing, Vol. 62, 2002, pp. 1314-1333, August 2002.

Celandroni Nedo, Davoli Franco, Ferro Erina "Static and Dynamic Resource allocation In a Multiservice Satellite Network with Fading", to appear on International Journal on Satellite Communications, special issue on" QoS on satellite IP networks", 2003.

Celandroni Nedo, Potorti' Francesco "Maximising single connection TCP goodput by trading bandwidth for BER", International Journal of Communication Systems, Vol. 16, No. 1, pp. 63-79, February 2003.

Caruso Antonio, Chessa Stefano, Maestrini Piero, Santi Paolo "Fault-Diagnosis of Grid Structures", Theoretical Computer Science, No. 2, vol. 290, p. 1149-1174, 2003.

Franck Laurent, Potorti' Francesco "GaliLEO: a simulation tool for LEO satellite constellations", to appear on SIMULATION: Transactions of The Society for Modeling and Simulation International, 2003.

M.A. Bonuccelli, F. Martelli, S. Pelagatti "Optimal Packet Scheduling in Tree-Structured LEO Satellite Clusters", to appear on ACM/Kluwer Mobile Networks and Applications (MONET), 2003

S.K. Das, M.C. Pinotti "Load Balanced and Optimal Disk Allocation Strategy for Partial Match Queries on Multi-dimensional Files", to appear on IEEE Transactions on Parallel and Distributed Systems, 2003.

ISTI Authors (conference papers):

Celandroni Nedo, Ferro Erina, Potorti' Francesco, Chimienti Antonio, Lucenteforte Antonio "Experimental results of MPEG-2 coded video transmission over a noisy satellite link", proceedings of the International Conference on Telecommunications ITC'98, Porto Carras, Grece, 22-25 June 1998, pp. 221-225.

Celandroni Nedo, Ferro Erina, Potorti' Francesco "An emulator for testing the performance of framed access schemes", proceedings of GLOBECOM 98, Sydney, Australia, 8-12 November 1998, pp. 1590-1594.

Krishnamurthi, G., Chessa, S., and Somani, A. "Fast Recovery Protocol for Database and Link Failures in Mobile Networks", IC3N 98, Seventh International Conference on Computer Communications and Networks, Lafayette, Louisiana, USA, 12-15 October, 1998, pp.32-39.

Maestrini, P., and Santi, P. "A Self-Diagnosis Algorithm for Hypercube Networks and its Application to VLSI Circuit Testing", DDECS-98- International Workshop on Design and Diagnostic of Electronic Circuits and Systems, vol. 1, 11, Szczyrk, Poland 1998.

Celandroni Nedo, Ferro Erina, Potorti' Francesco , Laurent Frank "GaliLEO. A simulation tool for traffic on LEO satellite constellations. Presentation of the architecture", proceedings of the COST Workshop, Toulouse (F), 19-20 May 1999, pp. 145-153.

Chessa, S., Sallay, B. and Maestrini, P. "Diagnostic Model and Diagnosis Algorithm of a SIMD Computer", Lecture Notes on Computer Science 1667, Springer-Verlag, Proc. EDCC-3 Conference on Dependable Computing, Prague, Czech Republic, 15-17 September 1999, pp.283-300.

Maestrini, P., and Santi, P. "Self-Validating Diagnosis of Hypercube Systems", 1999 IEEE Pacific Rim International Symposium on Dependable Computing, vol. 1, 228, Hong Kong 1999.

Krishnamurthi, G., Chessa, S., and Somani, A., "Optimal Replication of Location Information in Mobile Networks", ICC 99, International Conference on Communications, Vancouver, BC Canada, 6-10 June, 1999, pp.1768-1772.

M.A. Bonuccelli, M.C. Cl "EDD Algorithm Performance Guarantee for Periodic Hard-Real-Time Scheduling in Distributed Systems", IEEE IPPS/SPDP 1999 Conference, San Juan, Puerto Rico, April 12 - 16, 1999, pp. 668-677.

Celandroni Nedo, Ferro Erina, "An FH-TDMA VSAT system in Ka band for multimedia traffic using jitter-free bandwidth allocations on demand", proceedings of the 6th Ka band Utilisation Conference, May 31-June 2, 2000, Cleveland, Ohio, USA, pp. 373-380.

Franck Laurent, Potorti' Francesco "GaliLEO: a simulation tool for LEO satellite constellations", proceedings of the IST Mobile Summit, Galway (GB), pp. 735-758, October 2000.

Celandroni Nedo, Ferro Erina, Potorti' Francesco, Antonio Chimienti, Maurizio Lucenteforte "DRS compression applied to MPEG-2 video data transmitted over a satellite channel", Proceedings of ISCC'2000, Antibes-Juan les Pins, 4-6 July 2000, ppc.

Celandroni Nedo, Ferro Erina, Potorti' Francesco "Performance evaluation of a multi-level allocation algorithm for VBR traffic over a geostationary satellite", proceedings of SPECTS 2000, Vancouver, Canada, July 16-20 2000, pp. 452-457.

Caruso, A., Chessa, S. and Maestrini, P. "Comparison-Based Diagnosis of VLSI Wafers", Third Design & Diagnostic of Electronic Circuits and Systems Workshop, Smolenice Castle, Slovakia, 5-7 April 2000, pp.227-232.

Caruso, A., Chessa, S., Maestrini, P. and Santi, P. "Diagnosis of Regular Structures", DSN 2000, International Conference on Dependable Systems and Networks, New York, USA, 25-28 June 2000, pp.213-222.

Caruso, A., Chessa, S., Maestrini, P. and Santi, P. "Reliable Diagnosis of Grid-Connected Systems", LATW 2000, first Latin-American Test Workshop, Rio de Janeiro, Brazil, 13 - 15 March 2000, pp.162-165.

Caruso, A., Chessa, S. and Maestrini, P. "Wafer-Scale VLSI Testing", TMRCS 2000, Test Methods and Reliability of Circuits and Systems, Grassau, Germany, 19-21 March 2000, pp.4.

M.A. Bonuccelli, S. Pelagatti "Optimal On Demand Packet Scheduling in Single-Hop Multichannel Communication Systems", proceedings of the IEEE IPDPS 2000 Conference, Cancun, Mexico, May 1-5, 2000 pp. 343-352.

Celandroni Nedo, Ferro Erina, Potorti' Francesco, Saviozzi Giacomo, Boldrini Marco "The IntraCoastal Satellite Communicator System", Proceedings of 19th AIAA International Communications Satellite Systems Conference, Toulouse (F), 17-20 April, 2001, Vol. 3, Session N. 32, Paper N. 282.

Bolla Raffaele, Celandroni Nedo, Davoli Franco, Ferro Erina, Marchese Mario "The effect of a-priori fade level information on bandwidth control in a satellite channel: comparisons in a real case ", proceedings of SPECTS 2001, Orlando (USA), July 15-19, 2001, pp. 43-50.

Bolla Raffaele, Celandroni Nedo, Davoli Franco, Ferro Erina, Marchese Mario "A Control Architecture for Short- and Medium-Term Bandwidth Allocation in Satellite Channels with Fading", proceedings of the 7th Ka band Utilisation Conference, September 26-28, 2001, S. Margherita Ligure (Italy), pp. 459-466.

Santi, P. and Chessa, S. "Comparison-Based System-Level Fault Diagnosis in Ad-Hoc Networks", SRDS 2001, Symposium on Reliable and Distributed Systems, New Orleans, 28-31 October 2001, pp.257-266.

M.A. Bonuccelli, M.C. Cl "The Performance Guarantee of Static Priority Scheduling for Periodic Real Time Traffic in Input-Queued Switches", Telecommunication Systems Conference, Dallas, March 15-18, 2001.

Y. Guo, S.K. Das, M.C. Pinotti "A new Hybrid Broadcast scheduling Algorithm for Asymmetric Communication Systems: Push and Pull Data based on Optimal Cut-Off Point", ACM Internat. Workshop on Modeling Analysis and Simulation of Wireless and Mobile Systems (MSWim 2001), Rome, July 2001, pp. 123–130.

Celandroni Nedo, Ferro Erina, Sapia Salvatore, Maifreni Barbara, Vitez Marko, Babich Fulvio "An FH-TDMA/TDM satellite communication system for employment in satellite Ka band", proceedings of the EMPS 2002, Baveno (Stresa, Italy), September 25-28, 2002, pp. 289-298.

Celandroni Nedo, Davoli Franco, Ferro Erina, Vignola Stefano, Zappatore Sandro, Zinicola Andrea "Quality of service measurements of video encoded sequences over an emulated Ka band satellite environment", proceedings of the 8th Ka band Utilisation Conference, Baveno (Stresa, Italy), September 25-28, 2002, pp. 429-437.

A.A. Bertossi, M.C. Pinotti, R. Tan "Channel Assignment with Separation for Special Classes of Wireless Networks: Grids and Rings", 2nd Intern. Workshop on Parallel and Distributed Computing Issues in Wireless Networks and Mobile Computing, April 15-19, 2002, Fort Lauderdale, Florida.

M.C. Pinotti, N. Saxena "Push less and pull the current highest demanded data item to decrease the waiting time in asymmetric communication environments", 4th Internat. Workshop on Distributed Computing, Special Day on Wireless Networks, December 28-31, 2002, Calcutta, India.

Chessa Stefano, Maestrini Piero "Dependable and Secure Information Storage and Retrieval in Wireless, Mobile Networks". DSN 2003, International Conference on Dependable Systems and Networks, San Francisco, CA USA, 22-25 June 2003.

Urpi, M.A. Bonuccelli, S. Giordano "Modelling cooperation in ad-hoc networks: selfishness vs trade-offs", WiOpt'03 Workshop: Modeling and Optimization in Mobile, Ad Hoc and Wireless Networks, March 3-5, 2003, INRIA Sophia-Antipolis, France.

A.A. Bertossi, M.C. Pinotti, R. Rizzi " Allocating Servers in Info-stations for Bounded Simultaneous Requests", Dipartimento di Informatica e Telecomunicazioni, to appear on the proceedings of the IEEE Internat. Parallel and Distributed Processing Symposium, April 22-26, 2003, Nice, Francia

A.A. Bertossi, M.C. Pinotti, R. Rizzi "Channel Assignment with Separation on Trees and Interval Graphs", Dipartimento di Informatica e Telecomunicazioni, to appear on the proceedings of the 3rd Internat. Workshop on Wireless, Mobile and Ad Hoc Networks, April 26, 2003.