

EXTENDED CURRICULUM VITAE

Konstantinos Oikonomou

December 9, 2022

Contents

1	Personal Information	1
2	Brief Description	1
2.1	Occupation	1
2.2	Education	2
2.3	Relevant Work Experience	3
3	Main Research Activity	3
3.1	Medium Access Control (MAC) in Wireless Networks	4
3.1.1	Topology-Independent Medium Access Control	5
3.1.2	Synchronization and Fairness	6
3.1.3	Dual-mode Operation	6
3.2	Scalable and Distributed Facility Location	7
3.2.1	Exploitation of Strictly Local Information	7
3.2.2	Exploitation of Local Information	9
3.3	Cloud/fog Computing Environments	9
3.3.1	Facility Location in Cloud Computing Environments	9
3.3.2	Architecture	10
3.3.3	Information Dissemination	10
3.3.4	Cloud Gaming	11
3.4	Information Dissemination in Computer Networks	11
3.4.1	Probabilistic Flooding Studies and Applications	12
3.4.2	Probabilistic Flooding and Largest Eigenvalue/Principal Eigenvector	12
3.4.3	Random Walkers	13
3.4.4	Dominating Sets	14
3.5	Spectrum Analysis	14
3.6	Virtual Reality Applications and Network Users	15
3.7	Synchronization in Wireless Sensor Networks	16
3.8	Energy Consumption in Networks	17
3.8.1	Traffic Load	17
3.8.2	Routing	18
3.8.3	Sink Placement for Energy Consumption Minimization	18
3.8.4	Recharger Placement for Recharging Distance Minimization	19
3.8.5	The Common Facility Location Problem for Sink and Recharger	19
3.9	Experimental IoT Environments and Applications	19
3.9.1	Ionian University Demo Wireless Network	19
3.9.2	Vehicular Environments	20
3.9.3	UAV Environments	20
3.9.4	Smart City and Smart Tourism	21
3.9.5	Smart Agriculture	21
3.10	Various Research Topics (Security, Design, Social Networks, Education)	22
4	Additional Research Activities	22
4.1	Synopsis of Research Interests	23
4.2	List of Selected Publications	23
4.3	Best Paper Awards	24
4.4	Selected Collaborations (Number of Publications: 33)	24
4.4.1	KAUST / University of Quebec (INRS, Montreal), 2011-today	24

4.4.2	University of Glasgow, 2011-2014	25
4.4.3	Boston University, 2007-2014	26
4.5	Ph.D. Supervision	26
4.5.1	Graduates (7)	26
4.5.2	Ph.D. Students (5)	27
4.5.3	Member of Ph.D. Advisory/Examination Committees (10)	27
4.6	Editorials	28
4.6.1	Journals (7)	28
4.6.2	Conference Proceedings (3)	28
4.7	Main Scientific Talks (9)	28
4.8	Reviews	29
4.9	Conference Organization (9)	29
5	Research and Development Programmes	30
5.1	Participation in Funded Research and Development Projects	30
5.1.1	Main Funded Projects (9)	30
5.1.2	Publications per Funded Project	31
5.2	Project Proposal Preparation	40
6	Teaching	40
6.1	Courses	40
6.2	Undergraduate and Postgraduate Supervision (84)	40
6.3	Summer Schools (4)	40
7	Administrative Work	41
8	List of Publications (138)	41
8.1	Referred Publications(129)	41
8.1.1	Journals (46)	41
8.1.2	Conferences (83)	44
8.2	Various Publications and Editions (9)	51
8.2.1	Journals	51
8.2.2	Conferences	51
8.2.3	Book Editing	51
8.2.4	Book Chapters	52

1 Personal Information

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2 Brief Description

Konstantinos Oikonomou (Ph.D., M.Sc., DIC, MEng) is a full professor at the Department of Informatics of the Faculty of Information Science and Informatics of the Ionian University in the field of “Computer Networks.” He has served as the Dean of the same faculty¹ from December 2017 to August 2021 and Head of the same department between May to October 2017.

He has authored in total 138 scientific publications (p. 41) and 129 correspond to refereed publications: 46 published in refereed journals and 83 in refereed conferences.² Currently, there are 1127 cross-references to his work and the index metrics are h-index 19, g-index 28 and i10-index 27.³

He has received the best paper award for paper “Player Assignment in MEC Gaming for Social Interactivity and Server Provisioning Optimization” from 2021 IEEE Symposium on Computers and Communications (ISCC) and for paper “Power Efficiency Analysis for Topology-Unaware TDMA MAC Policies in Ad-Hoc Networks” from Proceedings of the 38th Annual Hawaii International Conference on System Sciences (HICSS 2005).

There are 7 Ph.D. graduations so far under his immediate supervision and he currently supervises 5 Ph.D. students that are in various levels of progress (p. 26). He is and has been heavily involved in 9 funded research and development projects and numerous others with smaller roles (p. 30). He has participated in the committees and the organization process of 9 international conferences (p. 29) and he has edited the proceedings of 3 of them.

He is currently a member of the editorial board of Computer Networks, Elsevier, and the recent Journal on Future and Evolving Technologies of the International Telecommunication Union (ITU). He has a reach teaching experience and has supervised 84 postgraduate and undergraduate these during undergraduate (35) and postgraduate (49) courses, respectively.

He has been employed as a research and development engineer by the hellenic industry of information and telecommunication Intracom S.A. for five years (1999-2005). He has served with the greek air force⁴ for twelve months as telecom engineer. He has been employed as teaching staff at the Departments of Informatics of University of Ioannina kai Ionian University, respectively, in computer networks. He is fluent in Greek and English.

2.1 Occupation

He is a full Professor since April 2017 in the area of “Computer Networks” at the Department of Informatics of the Faculty of Information Science and Informatics of the Ionian University. He has held this faculty position as Lecturer and consequentially as Assistant and Associate Professor since April 2007. He has served as Head of Department of the Department of Informatics from May 2017 to October 2017, from May 2018 to May 2020 as Director of the M.Sc. postgraduate

¹This particular faculty consists of the Department of Informatics and the Department of Archives, Library Science and Museology.

²There are 9 publications that have not been refereed correspond to various case, e.g., there were invited papers, abstracts, editing of conference volumes or project presentations (p. 51).

³Source: Google Scholar using the Publish or Perish software.

⁴Compulsory service.

course “Research Directions in Informatics” of the Department of Informatics of the Ionian University. From December 2017 to August 2021 he served as Dean of the Faculty of Information Science and Informatics of the Ionian University.

OCCUPATION

April 2007 - present Ionian University Dept. of Informatics	Faculty member (Computer Networks) Professor (January 2021 - today), Associate Professor (April 2017-January 2021), Assistant Professor (June 2011-April 2017), Lecturer (April 2007-June 2011)
Dec. 2017 - August 2021 Ionian University	Faculty of Information Science and Informatics Dean
May 2017-October 2017 Ionian University	Department of Informatics Head
May 2018 - May 2020 Dept. of Informatics Ionian University	M.Sc. Course “Research Directions in Informatics” Director

2.2 Education

He graduated from the Department of Computer Engineering and Informatics of the University of Patras (Greece) in July 1998⁵ with an overall grade 8.23/10. His diploma thesis focused on video coding techniques to allow for efficient streaming over the network and was under Prof. Athanassios Skodras.

From September 1998 to September 1999 he studied at the M.Sc. postgraduate course in “Communications and Signal Processing” of Electrical & Electronics Engineering Department in Imperial College, London. During this course, the focus of his studies was in telecommunications and his postgraduate thesis, “Data Link Control Optimization in Multiple Access for Mobile Communications,” was supervised under Prof. Mustafa K. Gurcan.

From January 2000 to October 2004, his focus was on his Ph.D. studies⁶ “Topology-Unaware TDMA MAC Policies for Ad Hoc Networks,” which took place at the Department of Informatics and Telecommunications at the National and Kapodistrian University of Athens under the supervision of Prof. Ioannis Stavrakakis. **EDUCATION**

2000 - 2004 National and Kapodistrian University of Athens	Ph.D. (Dept. of Informatics & Telecommunications) <i>Ph.D. Thesis Title:</i> Topology-Unaware TDMA MAC Policies for Ad Hoc Networks
1998 - 1999 Imperial College	M.Sc./DIC in Communications and Signal Processing (Electrical & Electronic Engineering Dept.) <i>M.Sc. Thesis Title:</i> Data Link Control Optimization in Multiple Access for Mobile Communications

⁵Studies in this engineering department correspond to full-time five years courses equivalent to MEng.

⁶Konstantinos Oikonomou. “Topology-Unaware MAC Policies for Ad Hoc Networks”. Text in greek. Ph.D. Thesis. National and Kapodistrian University of Athens, 2004.

1993 - 1998
University of Patras

MEng (Dept. of Computer Engineering & Informatics)

5 years full time study at the Faculty of Engineering.

Diploma Thesis Title: Modern Video Coding Techniques

2.3 Relevant Work Experience

He has been working as a research and development engineer from December 1999 at the greek industry of informatics and telecommunications Intracom S.A., particularly at the General Research and Development Division, Development Programmes Department. For two years (2000-2002), his role was of researcher/engineer in the area of funded research projects in telecommunications and computer networks. One milestone of his carrier was his involvement in the development of a HiperLAN/2 prototype.⁷ Next, he became the coordinator of such programs, and he was active in proposal submissions from European or national funds. He left Intracom S.A. in January 2005 to follow a research carrier.

He got a (not permanent) teaching position at the Department of Informatics of the University of Ioannina, teaching courses relevant to communications and computer networks. He was also working as a postdoc researcher at the Department of Informatics and Telecommunications of the National and Kapodistrian University of Athens, being involved in the research project Autonomic Network Architecture (ANA),⁸ a FET (Future Emerging Technologies) project of the European Committee.

WORK EXPERIENCE

10/2004 - 6/2010

National and Kapodistrian University of Athens

Dept. of Informatics and Telecommunications

Post-Doctoral Research in Autonomous Networks

10/2006 - 4/2007

Ionian University - Dept. of Informatics

Teaching two courses in the area of computer networks

3/2006 - 8/2006

University of Ioannina - Dept. of Informatics

Teaching two courses in the area of computer networks

12/1999 - 1/2005

Intracom S.A. - R&D General Division

Full time occupation as a research and development engineer

3 Main Research Activity

His research activity starts with the beginning of his Ph.D. studies⁹ in 2000. His research work can be categorized as follows (each subsection corresponds to a main research category):

3.1 Medium Access Control (MAC) in Wireless Networks

3.1.1 Topology-Independent Medium Access Control

3.1.2 Synchronization and Fairness

⁷A Wireless LAN that at the time was considered as competitive to WiFi.

⁸Autonomic Network Architecture (ANA). [(FET) IST-27489]. *Role: Post-doc researcher on behalf of the National & Kapodistrian University of Athens.* 2005-2010.

⁹Oikonomou, "Topology-Unaware MAC Policies for Ad Hoc Networks", see n. 6, p. 2.

- 3.1.3 Dual-mode Operation
- 3.2 Scalable and Distributed Facility Location
 - 3.2.1 Exploitation of Strictly Local Information
 - 3.2.2 Exploitation of Local Information
- 3.3 Cloud/fog Computing Environments
 - 3.3.1 Facility Location in Cloud Computing Environments
 - 3.3.2 Architecture
 - 3.3.3 Information Dissemination
 - 3.3.4 Cloud Gaming
- 3.4 Information Dissemination in Computer Networks
 - 3.4.1 Probabilistic Flooding Studies and Applications
 - 3.4.2 Probabilistic Flooding and Largest Eigenvalue/Principal Eigenvector
 - 3.4.3 Random Walkers
 - 3.4.4 Dominating Sets
- 3.5 Spectrum Analysis
- 3.6 Virtual Reality Applications and Network Users
- 3.7 Synchronization in Wireless Sensor Networks
- 3.8 Energy Consumption in Networks
 - 3.8.1 Traffic Load
 - 3.8.2 Routing
 - 3.8.3 Sink Placement for Energy Consumption Minimization
 - 3.8.4 Recharger Placement for Recharging Distance Minimization
 - 3.8.5 The Common Facility Location Problem for Sink and Recharger
- 3.9 Experimental IoT Environments and Applications
 - 3.9.1 Ionian University Demo Wireless Network
 - 3.9.2 Vehicular Environments
 - 3.9.3 UAV Environments
 - 3.9.4 Smart City and Smart Tourism
 - 3.9.5 Smart Agriculture
- 3.10 Various Research Topics (Security, Design, Social Networks, Education)

This combination of different areas in the wide scientific area of computer networks provided the opportunity to tackle various problems in an interdisciplinary manner, even though the research results required a significant effort to be achieved—the research activity of Prof. K. Oikonomou is described briefly in the sequel going through all publications per category.

3.1 Medium Access Control (MAC) in Wireless Networks

Medium Access Control (MAC) is a challenging issue in wireless network environments. In cases of increased mobility and a large number of nodes, challenging performance issues are introduced. Analysis of performance is central in this area and the emphasis is on Time Division Multiple Access (TDMA).

3.1.1 Topology-Independent Medium Access Control

The main objective of Prof. K. Oikonomou's Ph.D. thesis¹⁰ was the study of throughput of medium access control (MAC) policies for ad hoc networks. Various properties of Galois fields' polynomials were investigated that formed the basis for determining nodes' transmissions. The existing deterministic medium access control policies were investigated and it was shown that there is a large number of unused resources in the forms of time slots. Given this observation, the next step was introducing a MAC policy that could utilize the unused resources and therefore, a probabilistic MAC policy was introduced. This policy was analytically studied and the conditions throughput increment – when compared to the existing deterministic policies – were identified both for high traffic load^{11,12,13} as well as for the general case.^{14,15} In addition, the behavior of these MAC policies under conditions of controlled topology were investigated^{16,17} and the conditions that need to be satisfied for having a throughput improvement by using such technology (e.g., smart antennas, power control). Finally, energy consumption consumption concepts were studied^{18,19} (energy consumption issues are presented in more detail in 3.8, p. 17).

In the sequel, a new MAC policy was studied, an adaptive one based on the previously mentioned probabilistic policy and allows for different values of the access probability for every

¹⁰**Abstract**—In this PhD thesis, the medium access control problem was investigated using topology-unaware policies for ad-hoc networks. At the beginning, the Deterministic Policy was studied, which is based on properties of polynomials on Galois fields, allowing each node at least one successful transmission per frame. This policy suffers from low throughput, which is the reason for introducing the Probabilistic Policy, a policy that is capable of using unused time slots under the Deterministic Policy. Analytical results regarding system throughput maximization are derived and simulation results confirm them. At the sequel, both policies are examined under topology control and system throughput increment is observed, especially under the Probabilistic Policy; this confirms the ability of the latter policy to use the unused time slots under the Deterministic Policy. However, it is observed that under certain mobility conditions, the system throughput may be lower than the case where no topology control was used in the system. Power consumption is also important and it was shown that it is increased under the Probabilistic Policy in a per frame basis. On the other hand, the power consumption per successful transmission may be decreased, especially when time constrained data packets are considered.

¹¹Konstantinos Oikonomou and Ioannis Stavrakakis. “A Probabilistic Topology Unaware TDMA Medium Access Control Policy for Ad Hoc Environments”. In: *Personal Wireless Communications* (Venice, Italy). Springer, Sept. 2003, pp. 291–305.

¹²Konstantinos Oikonomou and Ioannis Stavrakakis. “Throughput Analysis of a Probabilistic Topology-Unaware TDMA MAC Policy for Ad-Hoc Networks”. In: *Quality for All* (Stockholm, Sweden). Springer, Oct. 2003, pp. 172–181.

¹³Konstantinos Oikonomou and Ioannis Stavrakakis. “Analysis of a Probabilistic Topology-Unaware TDMA MAC Policy for Ad Hoc Networks”. In: *IEEE Journal on Selected Areas in Communications* 22.7 (Sept. 2004), pp. 1286–1300.

¹⁴Konstantinos Oikonomou and Ioannis Stavrakakis. “Load Analysis of Topology-Unaware TDMA MAC Policies for Ad Hoc Networks”. In: *Quality of Service in the Emerging Networking Panorama* (Barcelona, Spain). Springer, Sept. 2004, pp. 84–93.

¹⁵Konstantinos Oikonomou and Ioannis Stavrakakis. “Analysis of Topology-Unaware TDMA MAC Policies for Ad-Hoc Networks Under Diverse Traffic Loads”. In: *SIGMOBILE Mob. Comput. Commun. Rev.* 9.4 (Oct. 2005), pp. 25–38.

¹⁶Konstantinos Oikonomou, Nikos Pronios, and Ioannis Stavrakakis. “Performance Analysis of Topology-Unaware TDMA MAC Schemes for Ad Hoc Networks With Topology Control”. In: *Computer Communications* 28.3 (2005), pp. 313–324.

¹⁷Konstantinos Oikonomou, Nikos Pronios, and Ioannis Stavrakakis. “Performance Analysis of TDMA MAC Schemes for Ad-Hoc Networks With Topology Control”. In: *The Third Annual Mediterranean Ad Hoc Networking Workshop (Med-Hoc-Net 2004)* (Bodrum, Turkey). June 2004.

¹⁸Konstantinos Oikonomou and Ioannis Stavrakakis. “Energy Considerations for Topology-Unaware TDMA MAC Protocols”. In: *Ad Hoc Networks* 4.3 (2006), pp. 359–379.

¹⁹Konstantinos Oikonomou and Ioannis Stavrakakis. “Power Efficiency Analysis for Topology-Unaware TDMA MAC Policies in Ad-Hoc Networks”. In: *Proceedings of the 38th Annual Hawaii International Conference on System Sciences (HICSS 2005)* (Big Island, Hawaii). Jan. 2005, 287b–287b.

node and transmission given the result (success or not) of the previous transmission.^{20,21} A new MAC policy that attempts to reduce the unsuccessful transmissions by two-hop knowledge has also been proposed and its various advantages have been studied.^{22,23,24}

3.1.2 Synchronization and Fairness

Medium access control in ad hoc network environments employing Time Division Multiple Access (TDMA) mechanisms introduces specific challenges like fairness and synchronization.

Fairness along with throughput has been analytically studied using simulations for the previously mentioned medium access control protocols.²⁵ A distributed mechanism to alter the probability access was proposed such that to keep at high value an also distributed fairness metric.

A distributed synchronization protocol was also studied considering experimentation in a low-cost system to highlight its practical significance.^{26,27}

The employment of topology-unaware policies have been revisited recently considering vehicular network environments.²⁸ It was shown that safety applications that require reduced time delays could be achieved when utilizing different subframes depending on the automobiles' directions²⁹

3.1.3 Dual-mode Operation

A unified framework for studying ad hoc networks was also presented³⁰ helping to understand and analyze various concepts like quality of service (QoS) of the prototype wireless LAN net-

²⁰Konstantinos Oikonomou and Ioannis Stavrakakis. "Throughput Analysis of an Aloha-Based MAC Policy for Ad Hoc Networks". In: *Challenges in Ad Hoc Networking: Fourth Annual Mediterranean Ad Hoc Networking Workshop, June 21–24, 2005* (Île de Porquerolles, France). Springer, June 2005, pp. 219–223.

²¹Konstantinos Oikonomou and Ioannis Stavrakakis. "An Adaptive Time-spread Multiple-access Policy for Wireless Sensor Networks". In: *EURASIP Journal on Wireless Communications and Networking* 2007.1 (Jan. 2007), pp. 24–24.

²²Vasileios Dragonas, Georgios Tsoumanis, and Konstantinos Oikonomou. "A Refined Topology-Independent Probabilistic TDMA MAC Policy for Ad Hoc Networks". In: *2021 International Balkan Conference on Communications and Networking (BalkanCom)*. Novi Sad, Serbia, Sept. 2021, pp. 61–65.

²³Vasileios Dragonas, Georgios Tsoumanis, and Konstantinos Oikonomou. "A Probabilistic Refined Policy For Topology Independent Medium Access Control In Ad Hoc Network Environments". In: *ITU Journal on Future and Evolving Technologies - Emerging trends and applications in future communication networks* 3.2 (Sept. 2022), pp. 483–497.

²⁴Vasileios Dragonas, Dimitrios Kallergis, Georgios Tsoumanis, and Konstantinos Oikonomou. "On Utilizing Unused Slots In Topology-Transparent TDMA MAC Policies for Ad Hoc Networks". In: *2022 Global Information Infrastructure and Networking Symposium (GIIS) (GIIS'22)*. Argostoli, Greece, Sept. 2022.

²⁵Vasileios Dragonas, Georgios Tsoumanis, George Koufoudakis, Asterios Papamichail, Konstantinos Oikonomou, and Ioannis Stavrakakis. "A Fairness-Aware topology independent TDMA MAC policy in time constrained wireless ad hoc networks". In: *Computer Networks* 171 (2020), p. 107157.

²⁶Asterios Papamichail, Vasileios Dragonas, George Koufoudakis, Konstantinos Oikonomou, Georgios Tsoumanis, and Ioannis Stavrakakis. "Low-cost Device Implementation of a Topology Independent MAC (TiMAC) Policy". In: *Third International Balkan Conference on Communications and Networking 2019 (BalkanCom'19)*. Skopje, North Macedonia, June 2019.

²⁷Georgios Tsoumanis, Asterios Papamichail, Vasileios Dragonas, George Koufoudakis, Constantinos T Angelis, and Konstantinos Oikonomou. "Implementation of a Topology Independent MAC (TiMAC) Policy on a Low-Cost IoT System". In: *Future Internet* 12.5 (2020), p. 86.

²⁸Vasileios Dragonas, Konstantinos Oikonomou, and Ioannis Stavrakakis. "A Topology-Independent TDMA MAC Policy for Safety Applications in Vehicular Networks". In: *BalkanCom 2017, First International Balkan Conference on Communications and Networking, Tirana, Albania* (Tirana, Albania). June 2017.

²⁹Vasileios Dragonas, Konstantinos Oikonomou, and Ioannis Stavrakakis. "A Disjoint Frame Topology-Independent TDMA MAC Policy for Safety Applications in Vehicular Networks". In: *Ad Hoc Networks* 79 (2018), pp. 43–52.

³⁰Konstantinos Oikonomou and Nikos B Pronios. "Ad-Hoc Networking: A Unified Evaluation Framework". In: *IST Mobile & Communications Summit* (Aveiro, Portugal). June 2003.

work HiperLAN/2^{31,32} and particularly its transient behavior.³³ Working with this system and particularly with its dual operation in both 5 and 60 GHz^{34,35} was carried^{36,37} both analytical simulation models.³⁸ It was shown that this dual mode³⁹ is efficient and results in system capacity increment⁴⁰ under low mobility and high traffic load conditions among nearby nodes.

3.2 Scalable and Distributed Facility Location

The facility location problem is a classical one with various forms, the most well-known being the k -median problem when the number of facilities is known (k) and the UFL (uncapacitated facility location) problem when both the number and the location of the facilities need to be optimized given that there is a cost for their maintenance. The solution of such problems answers many modern networking problems like placing a server, a virtual machine, or a virtual network function in a network environment that can also be a cloud or a fog computing environment. In the general case, these problems are NP-hard and require global knowledge of the network parameters to be solved. Even though there are approximation approaches that reduce the complexity, the global knowledge requirement still remains. However, this is not a realistic approach in modern network environments that are inherently dynamic (frequent topology changes, diverse user demands, etc.). Therefore, the traditional centralized approaches are not suitable since they require the continuous accumulation of network data that change and may become obsolete before being processed. Eventually, these are not scalable approaches.

3.2.1 Exploitation of Strictly Local Information

Strictly local information corresponds to information that is available to an individual node. In order to tackle the previously mentioned scalability problem, the various mechanisms that decide

³¹Konstantinos Oikonomou, Ioannis Tenidis, and Ioannis Stavrakakis. “A Mechanism to Enable Differentiated Services QoS in HIPERLAN/2”. In: *8th IEEE International Conference on Telecommunications, Bucharest, Romania* (Bucharest, Romania). June 2001.

³²Konstantinos Oikonomou, Carmen Mas, and Ioannis Tenidis. “On QoS Management of H/2 Bearer Service for 3G Telecommunication Systems”. In: *3G Technologies and Applications, EURESCOM Summit* (Heidelberg, Germany). Nov. 2001, pp. 12–15.

³³Konstantinos Oikonomou and Nikos Pronios. “Transient Behavior of an Ad-Hoc Network Architecture Supporting an Enhanced Dual Mode HiperLAN/2 System”. In: *International Workshop on Wireless Ad-Hoc Networks, 2004*. (Oulu, Finland). May 2004, pp. 11–15.

³⁴Konstantinos Oikonomou, Athanasios Vaios, Sebastien Simoens, Pietro Pellati, and Ioannis Stavrakakis. “A Centralized Ad-Hoc Network Architecture (CANA) Based on Enhanced HiperLAN/2”. In: *14th IEEE Proceedings on Personal, Indoor and Mobile Radio Communications, 2003. PIMRC 2003*. (Beijing, China). Vol. 2. Sept. 2003, pp. 1336–1340.

³⁵Athanasios Vaios, Konstantinos Oikonomou, and Ioannis Stavrakakis. “A Centralized Routing Scheme Supporting Ad Hoc Networking in Dual Mode HiperLAN/2”. In: *IST Mobile & Communications Summit* (Aveiro, Portugal). June 2003, pp. 15–18.

³⁶Konstantinos Oikonomou, Konstantinos Ntagkounakis, Athanasios Vaios, Nikolaos Zinelis, and Ioannis Stavrakakis. “Layered Architecture and Modules of CANA Supporting Dual Mode HiperLAN/2”. In: *International Workshop on Wireless Ad-Hoc Networks, 2004*. (Oulu, Finland). May 2004, pp. 172–176.

³⁷Athanasios Vaios, Konstantinos Oikonomou, Nikolaos Zinelis, Konstantinos Ntagkounakis, and Ioannis Stavrakakis. “On Supporting Dual-Mode HiperLAN/2: Architecture and Overhead”. In: *13th IST Mobile & Wireless Communications Summit* (Lyon, France). June 2004, pp. 27–30.

³⁸Athanasios Vaios, Konstantinos Oikonomou, and Ioannis Stavrakakis. “Analysis of a Topology Control Paradigm in WLAN/WPAN Environments”. In: *Computer Communications* 29.11 (2006), pp. 2096–2108.

³⁹Athanasios Vaios, K Oikornou, Pietro Pellati, Sebastien Simoens, and Ioannis Stavrakakis. “A Dual-Band HiperLAN/2-Based Architecture for Indoor Hotspot Applications”. In: *International Workshop on Wireless Ad-Hoc Networks, 2004*. (Oulu, Finland). May 2004, pp. 6–10.

⁴⁰Athanasios Vaios, Konstantinos Oikonomou, Nikolaos Zinelis, and Ioannis Stavrakakis. “Increasing Capacity in Dual-Band WLANs Through Ad-Hoc Networking”. In: *International Journal of Wireless and Mobile Computing (IJWMC), Special Issue on Wireless Ad Hoc Networking* (2005).

on gradually better locations (in terms of the overall cost) for the facility and adapt automatically to dynamic network changes were studied. Even though they may not always conclude on the optimal location (non-realistic in any case in highly dynamic environments where the optimal location continuously changes), they allow for overall cost reduction for every movement of the facility compared to the previous location. Under this light, the first attempt was service migration⁴¹ and it was analytically shown that moving a facility between two neighbor nodes in order to reduce the overall cost is possible by exploiting information that is locally available at the node hosting the facility. In particular, it was shown that it is enough to have knowledge of the aggregate traffic load arriving at the node that hosts the facility to decide the particular neighbor node that the facility should move or not reduce the overall cost. In this light, a migration policy was proposed relying on strictly local information. As it was analytically shown, this mechanism can move the facility until the optimal location (i.e., the solution of the 1-median problem) if the topology has a unique shortest path tree (e.g., tree topologies, topologies of different link weights etc.) This mechanism was further extended for the general case of topologies and more than one facilities and its properties were both analytically investigated and through simulations.^{42,43} Even though the optimal location was proved only for the case of topologies of unique shortest path trees and one facility, it was shown that the proposed mechanisms have a satisfactory performance in the sense that they reduce the overall cost even with a small number of movements and respond immediately to changes of the network characteristics.

This particular approach was enhanced considering replicas of a facility⁴⁴ and the broader idea of changing the number of facilities in the network and migrating them was studied considering cloud computing environments⁴⁵ (further in 3.3.1, p. 9). The idea of migration a facility has been employed in various environments like peer-to-peer networks to achieve small cost content movement.⁴⁶ However, it is shown that it has a specific potential in cloud computing environments.

Energy consumption was studied considering facility location and more specifically employing migration⁴⁷ or as minimizing the overall consumed energy⁴⁸ (further on reducing energy consumption are presented in 3.8, p. 17).

⁴¹Konstantinos Oikonomou and Ioannis Stavrakakis. “Scalable Service Migration: The Tree Topology Case”. In: *5th Annual Mediterranean Ad Hoc Networking Workshop* (Lipari, Italy). 2006.

⁴²Konstantinos Oikonomou, Ioannis Stavrakakis, and Alexios Xydias. “Scalable Service Migration in General Topologies”. In: *2008 International Symposium on a World of Wireless, Mobile and Multimedia Networks* (Newport Beach, California). June 2008, pp. 1–6.

⁴³Konstantinos Oikonomou and Ioannis Stavrakakis. “Scalable Service Migration in Autonomic Network Environments”. In: *IEEE Journal on Selected Areas in Communications* 28.1 (Jan. 2010), pp. 84–94.

⁴⁴Konstantinos Oikonomou, Giorgos Tsioutsoulouklis, and Sonia Aïssa. “Scalable Facility Placement for Communication Cost Reduction in Wireless Networks”. In: *2012 IEEE International Conference on Communications (ICC)* (Ottawa, Canada). June 2012, pp. 5118–5123.

⁴⁵Eleni Kavvadia, Spyros Sagiadinos, Konstantinos Oikonomou, Giorgos Tsioutsoulouklis, and Sonia Aïssa. “Elastic Virtual Machine Placement in Cloud Computing Network Environments”. In: *Computer Networks* 93.Part 3 (2015). Cloud Networking and Communications II, pp. 435–447.

⁴⁶Konstantinos Oikonomou, Spyros Sioutas, and Ioannis Stavrakakis. “Scalable Communication Cost Reduction: The Chord Case”. In: *2009 8th IFIP Annual Mediterranean Ad Hoc Networking Workshop* (Haifa, Israel). June 2009, pp. 42–47.

⁴⁷Konstantinos Oikonomou and Sonia Aïssa. “Dynamic Sink Assignment for Efficient Energy Consumption in Wireless Sensor Networks”. In: *2012 IEEE Wireless Communications and Networking Conference (WCNC)* (Paris, France). Apr. 2012, pp. 1876–1881.

⁴⁸Georgios Tsoumanis, Konstantinos Oikonomou, Sonia Aïssa, and Ioannis Stavrakakis. “Recharging Vehicle Distance Minimization in Wireless Sensor Networks”. In: *BalkanCom 2017, First International Balkan Conference on Communications and Networking, Tirana, Albania* (Tirana, Albania). June 2017.

3.2.2 Exploitation of Local Information

Local information refers to information about the network that can be acquired from its immediate neighborhood. Even though this is broader than strictly local information, it is still scalable to assume its knowledge for a few hops away from a node compared to the requirement for global knowledge.

Under this light, a new approach was proposed and studied^{49,50} that allows for information gathering from all nodes a few hops away from the node that hosts the facility, thus creating a “ball” of radius equal to the number of hops. It is assumed that all network information within this ball is available to the node hosting the facility at the center of the ball. There is some cost for this information to become available and depends on the radius. Apart from this information, on those nodes at the “skin” of the ball is mapped the traffic that is originated outside the ball. Being aware of this information, a centralized solution of either the q -median or the UFL problem is executed within the ball. A new position for the sink may be derived as well as replicating or merging. This procedure is repeated and terminates in the case of a static environment while it responds to the dynamic changes in dynamic environments. A critical factor of this approach is the radius that is closely related to the desired scalability and performance properties. Large values of the radius are better in terms of performance (e.g., the algorithm converges faster since large parts of the network are known), but the requirement for knowledge of large parts of the network introduces the scalability problem already mentioned. However, as it was analytically shown, small radius values (1 or 2) allow for performance comparable to larger values for both synthetic and real topologies and traffic conditions, thus reducing the scalability problem since there is no need for a large radius.

3.3 Cloud/fog Computing Environments

Cloud computing and fog computing environments have been studied recently to support a multitude of applications and devices. The main challenges are the services’ location, network architecture, information dissemination, and new applications like exceptionally demanding cloud gaming.

3.3.1 Facility Location in Cloud Computing Environments

The problem of facility location was considering assuming virtual machines as facilities in cloud computing environments.⁵¹ In particular, the s-UFL (scalable-Uncapaciated Facility Location) policy was proposed that utilizes replication and merging mechanisms along with the migration policy for deriving the locations of the virtual machines in a cloud computing network. The efficiency of this policy is thoroughly investigated and it is proved that overall cost reduction is possible under certain conditions also investigated. The simplicity of the implementation is another advantage of the proposed policy.

In addition, the S-CORE (Scalable communication Cost Reduction) policy is proposed that aims for the overall network cost reduction in (cloud computing) environments by efficiently

⁴⁹Nikolaos Laoutaris, Georgios Smaragdakis, Konstantinos Oikonomou, Ioannis Stavrakakis, and Azer Bestavros. “Distributed Placement of Service Facilities in Large-Scale Networks”. In: *IEEE INFOCOM 2007 - 26th IEEE International Conference on Computer Communications* (Barcelona, Spain). May 2007, pp. 2144–2152.

⁵⁰Georgios Smaragdakis, Nikolaos Laoutaris, Konstantinos Oikonomou, Ioannis Stavrakakis, and Azer Bestavros. “Distributed Server Migration for Scalable Internet Service Deployment”. In: *IEEE/ACM Transactions on Networking* 22.3 (June 2014), pp. 917–930.

⁵¹Kavvadia, Sagiadinos, Oikonomou, Tsioutsoulouklis, and Aïssa, see n. 45, p. 8.

utilizing the data centers' resources.^{52,53} It is a scalable policy that moves virtual machines located at servers achieving overall cost reduction and reduced networking load. Simulation results have demonstrated a significant network cost reduction. These results ended up in a Ph.D. graduation.⁵⁴

The problem of locating controllers in Software-Defined Network (SDN) environments has also been studied considering migration techniques.⁵⁵

3.3.2 Architecture

Various architectures have been proposed for the efficient support of fog/cloud computing environments and applications. A first attempt took place considering services⁵⁶ and similar proposal were introduced for cloud gaming environments^{57,58} and smart agriculture.⁵⁹ An interesting case is about fires and on-time alerts.⁶⁰

3.3.3 Information Dissemination

Information dissemination is important in these environments due to the large number of devices, users and services that introduce challenging scalability problems. The considered approaches had inherit scalability properties like random walkers^{61,62} (more in 3.4.3 at p. 13) and dominating

⁵²Fung Po Tso, Gregg Hamilton, Konstantinos Oikonomou, and Dimitrios Pezaros. "Implementing Scalable, Network-Aware Virtual Machine Migration for Cloud Data Centers". In: *2013 IEEE Sixth International Conference on Cloud Computing* (Santa Clara, USA). June 2013, pp. 557–564.

⁵³Fung Po Tso, Konstantinos Oikonomou, Eleni Kavvadia, and Dimitrios Pezaros. "Scalable Traffic-Aware Virtual Machine Management for Cloud Data Centers". In: *2014 IEEE 34th International Conference on Distributed Computing Systems (ICDCS)* (Tamilaldu, India). June 2014, pp. 238–247.

⁵⁴Eleni Kavvadia. "Virtual Machine Placement for Supporting Network Cloud Services". Text in greek. Ph.D. Thesis. Ionian University, June 2017.

⁵⁵Alexandros Zervopoulos and Konstantinos Oikonomou. "A Migration-Based Approach for the SDN Controller Placement Problem in Tree Topologies". In: *2021 International Balkan Conference on Communications and Networking (BalkanCom)*. Novi Sad, Serbia, Sept. 2021, pp. 127–132.

⁵⁶Kavvadia, Sagiadinos, Oikonomou, Tsioutsouloukalis, and Aïssa, see n. 45, p. 8.

⁵⁷Athanasios Tsipis, Vasileios Komianos, and Konstantinos Oikonomou. "A Cloud Gaming Architecture Leveraging Fog for Dynamic Load Balancing in Cluster-Based MMOs". In: *2019 4th South-East Europe Design Automation, Computer Engineering, Computer Networks and Social Media Conference (SEEDA-CECNSM)* (Piraeus, Greece). Sept. 2019, pp. 1–6.

⁵⁸Athanasios Tsipis, Konstantinos Oikonomou, Vasileios Komianos, and Ioannis Stavrakakis. "Performance Evaluation in Cloud-Edge Hybrid Gaming Systems". In: *Third International Balkan Conference on Communications and Networking 2019 (BalkanCom'19)*. Skopje, North Macedonia, June 2019.

⁵⁹Athanasios Tsipis, Asterios Papamichail, George Koufoudakis, Georgios Tsoumanis, Spyros E. Polykalas, and Konstantinos Oikonomou. "Latency-Adjustable Cloud/Fog Computing Architecture for Time-Sensitive Environmental Monitoring in Olive Groves". In: *AgriEngineering 2.1* (2020), pp. 175–205.

⁶⁰Athanasios Tsipis, Asterios Papamichail, Ioannis Angelis, George Koufoudakis, Georgios Tsoumanis, and Konstantinos Oikonomou. "An Alertness-Adjustable Cloud/Fog IoT Solution for Timely Environmental Monitoring Based on Wildfire Risk Forecasting". In: *Energies 13.14* (2020).

⁶¹Konstantinos Skiadopoulou, Konstantinos Oikonomou, Markos Avlonitis, Konstantinos Giannakis, Dimitrios Kogias, and Ioannis Stavrakakis. "Multiple and Replicated Random Walkers Analysis for Service Discovery in Fog Computing IoT Environments". In: *Ad Hoc Networks 93* (2019), p. 101893.

⁶²Konstantinos Skiadopoulou, Konstantinos Giannakis, Konstantinos Oikonomou, and Ioannis Stavrakakis. "Analysis of Multiple Random Walkers for Service Discovery in Fog Computing Network Environments". In: *Second International Balkan Conference on Communications and Networking 2018 (BalkanCom'18)*. Podgorica, Montenegro, June 2018.

sets⁶³ (more in 3.4.4 at p. 14) that were part of a Ph.D. thesis.⁶⁴

3.3.4 Cloud Gaming

Video games require a demanding network environment regarding bandwidth and jitter. This is one of the reasons that the research area of cloud/fog gaming has received increased research interest.⁶⁵ There are several problems like load balancing.⁶⁶

The research interest in this area also involves the problem of the user’s Quality of Experience (QoE). A facility location problem was studied and the particular locations concerning the user’s satisfaction were considered.⁶⁷ A new policy, i.e., Rendering Service Allocation Policy-RSAP), was proposed.⁶⁸ This attempt ended up to a Ph.D. graduation.⁶⁹ The interest in the area continued in future work that also received the best paper award⁷⁰ and further extended.⁷¹ A strategic placement to minimize expenditure was also investigated⁷² as well as fairness issues.^{73,74} A different approach employing graph spectra analysis was also investigated.⁷⁵

3.4 Information Dissemination in Computer Networks

The problem of information dissemination in large scale unstructured environments is studied and tackled using scalable policies in order to reduce the various disadvantages of the traditional

⁶³Konstantinos Skiadopoulos, Konstantinos Giannakis, Konstantinos Oikonomou, Ioannis Stavrakakis, and Sonia Aïssa. “Distributed Construction of d-Hop Connected Dominating Sets for Wireless Sensor Networks”. In: *2018 IEEE Global Communications Conference (GLOBECOM)*. Dec. 2018, pp. 1–7.

⁶⁴Konstantinos Skiadopoulos. “Information Dissemination and Dominating Sets on Wireless Sensor Networks”. Text in greek. Ph.D. Thesis. Ionian University, Dec. 2019.

⁶⁵Tsipis, Oikonomou, Komianos, and Stavrakakis, “Performance Evaluation in Cloud-Edge Hybrid Gaming Systems”, see n. 58, p. 10.

⁶⁶Tsipis, Komianos, and Oikonomou, “A Cloud Gaming Architecture Leveraging Fog for Dynamic Load Balancing in Cluster-Based MMOs”, see n. 57, p. 10.

⁶⁷Athanasios Tsipis, Konstantinos Oikonomou, Vasileios Komianos, and Ioannis Stavrakakis. “QoE-Aware Rendering Service Allocation in Fog-Assisted Cloud Gaming Environments”. In: *2020 5th South-East Europe Design Automation, Computer Engineering, Computer Networks and Social Media Conference (SEEDA-CECNSM)* (Corfu, Greece). 2020, pp. 1–8.

⁶⁸Athanasios Tsipis, Vasileios Komianos, Konstantinos Oikonomou, and Ioannis Stavrakakis. “Elastic Distributed Rendering Service Placement in Capacitated Cloud/Fog Gaming Systems”. In: *2020 11th International Conference on Information, Intelligence, Systems and Applications (IISA)* (Piraeus, Greece). 2020, pp. 1–8.

⁶⁹Athanasios Tsipis. “Network Resource Optimization in Cloud Computing Environments”. Ph.D. Thesis. Ionian University, Jan. 2021.

⁷⁰Athanasios Tsipis and Konstantinos Oikonomou. “Player Assignment in MEC Gaming for Social Interactivity and Server Provisioning Optimization”. In: *2021 IEEE Symposium on Computers and Communications (ISCC)* (Athens, Greece). Sept. 2021, pp. 1–7.

⁷¹Athanasios Tsipis and Konstantinos Oikonomou. “Joint optimization of social interactivity and server provisioning for interactive games in edge computing”. In: *Computer Networks* 212 (2022), p. 109028.

⁷²Athanasios Tsipis and Konstantinos Oikonomou. “ARPA: An autonomous renderer placement algorithm in distributed multimedia fog networks with delay guarantees”. In: *ITU Journal on Future and Evolving Technologies (ITU J-FET)* 2.2 (2021).

⁷³Athanasios Tsipis, Vasileios Komianos, and Konstantinos Oikonomou. “Fairness-Oriented Edge Allocation for Interactive Group Gaming in Edge Computing”. In: *2022 13th International Conference on Information, Intelligence, Systems and Applications (IISA)* (Corfu, Greece). 2022.

⁷⁴Athanasios Tsipis, Vasileios Komianos, Konstantinos Oikonomou, and Ioannis Stavrakakis. “Towards Fairness and QoE Based Edge Allocation for Multiplayer Virtual Reality Applications in Edge Computing”. In: *ITU Journal on Future and Evolving Technologies - Digital Continuum and Next Generation Networks* (2022).

⁷⁵Athanasios Tsipis, Sofia Fanarioti, Vasileios Komianos, Spyros Sioutas, and Konstantinos Oikonomou. “A Study on Robustness for the Single Server Location in Distributed Interactive Applications”. In: *2022 Global Information Infrastructure and Networking Symposium (GIIS) (GIIS’22)*. Argostoli, Greece, Sept. 2022.

flooding and random walkers approaches⁷⁶ The former, even though efficient concerning time that is upper bounded by the network’s diameter, they are demanding concerning the number of sent messages (of the order of the network links). On the other hand, the number of sent messages under the random walker’s mechanisms is reduced even though the time required to cover a particular network may be significantly large. Since it appears that the traditional flooding and random walkers mechanisms are complementary, one of the aims of the studies in this area was to bridge the gap among them by introducing novel and scalable approaches. Other approaches like dominating sets are also under consideration.

3.4.1 Probabilistic Flooding Studies and Applications

A first approach was the study of Probabilistic Flooding^{77,78} and it was shown that with the appropriate configuration, it results in covering the entire network while reducing the number of sent messages significantly and slightly increasing termination time. For the analysis, random graphs were considered. It was shown that Probabilistic Flooding creates a network of certain characteristics that allowed for using results from random graph theory concerning the performance of Probabilistic Flooding. A robust version was also studied⁷⁹ that was later extended taking into account data from the NASA Langley Research Center (LaRC) POWER Project.⁸⁰ Application for a sensor network for the case of historical buildings was also considered.⁸¹

3.4.2 Probabilistic Flooding and Largest Eigenvalue/Principal Eigenvector

Probabilistic flooding was also studied borrowing tools from algebraic graph theory. Coverage was represented analytically by a polynomial and its roots corresponded to the particular value of the forwarding probability. At the same time, various results that have been already present in the literature were confirmed.⁸² The extension of this approach provided for further analytical insights concerning the largest eigenvalues of the adjacency matrix and the eigenvector centrality of the nodes and an algorithm was proposed capable of approximating the value of the forwarding probability after showing that it converges.⁸³

The extension of this research approach revealed interesting properties concerning the largest eigenvalue λ_1 of the adjacency matrix and the principal eigenvector. Specifically, when Proba-

⁷⁶Konstantinos Oikonomou, Dimitrios Kogias, Leonidas Tzevelekas, and Ioannis Stavrakakis. “Investigation of Information Dissemination Design Criteria in Large-Scale Network Environments”. In: *2009 13th Panhellenic Conference on Informatics* (Corfu, Greece). Sept. 2009, pp. 163–167.

⁷⁷Konstantinos Oikonomou and Ioannis Stavrakakis. “Performance Analysis of Probabilistic Flooding Using Random Graphs”. In: *2007 IEEE International Symposium on a World of Wireless, Mobile and Multimedia Networks* (Helsinki, Finland). June 2007, pp. 1–6.

⁷⁸Konstantinos Oikonomou, Dimitrios Kogias, and Ioannis Stavrakakis. “Probabilistic Flooding for Efficient Information Dissemination in Random Graph Topologies”. In: *Computer Networks* 54.10 (2010), pp. 1615–1629.

⁷⁹Eleni Kavvadia, George Koufoudakis, and Konstantinos Oikonomou. “Robust Probabilistic Information Dissemination in Energy Harvesting Wireless Sensor Networks”. In: *2014 13th Annual Mediterranean Ad Hoc Networking Workshop (MED-HOC-NET)* (Piran, Slovenia). June 2014, pp. 63–70.

⁸⁰George Koufoudakis, Konstantinos Oikonomou, and Georgios Tsoumanis. “Adapting Probabilistic Flooding in Energy Harvesting Wireless Sensor Networks”. In: *Journal of Sensor and Actuator Networks* 7.3 (2018), p. 39.

⁸¹Konstantinos Skiadopoulos and Konstantinos Oikonomou. “Probabilistic Information Dissemination Aspects in Wireless Sensor Networks Located in Historical Buildings”. In: *2014 S.M.ART.BUIL.T International Conference* (Bari, Italy). Mar. 2014.

⁸²Konstantinos Oikonomou, George Koufoudakis, and Sonia Aïssa. “Probabilistic Flooding Coverage Analysis in Large Scale Wireless Networks”. In: *2012 19th International Conference on Telecommunications (ICT)* (Jounieh, Lebanon). Apr. 2012, pp. 1–6.

⁸³George Koufoudakis, Konstantinos Oikonomou, Konstantinos Giannakis, and Sonia Aïssa. “Probabilistic Flooding Coverage Analysis for Efficient Information Dissemination in Wireless Networks”. In: *Computer Networks* 140 (2018), pp. 51–61.

bilistic Flooding is initiated by a node of a higher value of the corresponding elements of the principal eigenvector, then network coverage is faster. The most important result is that four over the value of the largest eigenvalue ($\frac{4}{\lambda_1}$) corresponds to the particular value of the forwarding probability that is enough for full coverage.⁸⁴ This was part of the Ph.D. thesis.⁸⁵ This work was further extended for various topology cases and a new policy was introduced, namely the m -Probabilistic Policy where the information message at each step was forwarded to m (fixed) randomly selected neighbor nodes.⁸⁶ Moreover, experiments took place in a realistic environment to demonstrate the effectiveness of this analysis.⁸⁷

3.4.3 Random Walkers

Another considered approach was the employment of random walkers and replication mechanisms of random walkers either randomly or considering the underlying topology.^{88,89,90} Another interesting approach refers to random walkers that perform directional jumps according to a two-state behavioral model.⁹¹ Under this approach, revisiting certain network areas is avoided. A different approach concerning the analysis of coverage under a random walker⁹² has allowed for studying the problem of multiple random walkers and the analytical results were confirmed by simulations.⁹³ This work was further extended assuming random walk replications in a network.⁹⁴ Random walkers were implemented in a low-cost system to demonstrate their advantages.⁹⁵ Part of this work was included in a Ph.D. Thesis.⁹⁶

⁸⁴George Koufoudakis, Konstantinos Oikonomou, Sonia Aïssa, and Ioannis Stavrakakis. “Analysis of Spectral Properties for Efficient Coverage Under Probabilistic Flooding”. In: *2018 IEEE 19th International Symposium on A World of Wireless, Mobile and Multimedia Networks (WoWMoM) (IEEE WoWMoM 2018)*. Chania, Crete, Greece, June 2018, pp. 1–9.

⁸⁵George Koufoudakis. “Information Dissemination in Structured and Unstructured Networks”. Ph.D. Thesis. Ionian University, Feb. 2019.

⁸⁶Konstantinos Oikonomou, George Koufoudakis, Sonia Aïssa, and Ioannis Stavrakakis. “Probabilistic Flooding Performance Analysis Exploiting Graph Spectra Properties”. In: *IEEE/ACM Transactions on Networking* (2022), pp. 1–14.

⁸⁷Andreana Styliou, Alexandros Zervopoulos, Aikaterini Georgia Alvanou, George Koufoudakis, Georgios Tsoumanis, and Konstantinos Oikonomou. “Evaluation of Epidemic-Based Information Dissemination in a Wireless Network Testbed”. In: *Technologies* 8.3 (2020).

⁸⁸Dimitris Kogias, Konstantinos Oikonomou, and Ioannis Stavrakakis. “Replicated Random Walks for Service Advertising in Unstructured Environments”. In: *Advances in Ad Hoc Networking, Ad Hoc Networking Workshop (MED-HOC-NET), 2008 7th Annual Mediterranean* (Palma de Mallorca, Spain). Springer, June 2008, pp. 25–36.

⁸⁹Dimitris Kogias, Konstantinos Oikonomou, and Ioannis Stavrakakis. “Study of Randomly Replicated Random Walks for Information Dissemination Over Various Network Topologies”. In: *2009 Sixth International Conference on Wireless On-Demand Network Systems and Services* (Snowbird, Utah, USA). Feb. 2009, pp. 53–60.

⁹⁰Konstantinos Oikonomou, Dimitrios Kogias, and Ioannis Stavrakakis. “A Study of Information Dissemination Under Multiple Random Walkers and Replication Mechanisms”. In: *Proceedings of the Second International Workshop on Mobile Opportunistic Networking* (Pisa, Italy). MobiOpp ’10. New York, NY, USA: ACM, 2010, pp. 118–125.

⁹¹Leonidas Tzevelekas, Konstantinos Oikonomou, and Ioannis Stavrakakis. “Random Walk With Jumps in Large-Scale Random Geometric Graphs”. In: *Computer Communications* 33.13 (2010), pp. 1505–1514.

⁹²Konstantinos Skiadopoulos, Konstantinos Giannakis, and Konstantinos Oikonomou. “Random Walker Coverage Analysis for Information Dissemination in Wireless Sensor Networks”. In: *Technologies* 5.2 (2017), p. 33.

⁹³Skiadopoulos, Giannakis, Oikonomou, and Stavrakakis, see n. 62, p. 10.

⁹⁴Skiadopoulos, Oikonomou, Avlonitis, Giannakis, Kogias, and Stavrakakis, see n. 61, p. 10.

⁹⁵Aikaterini Georgia Alvanou, Konstantinos Skiadopoulos, Konstantinos Giannakis, Konstantinos Oikonomou, and Georgios Tsoumanis. “Random Walkers Coverage Experimentation and Evaluation in Low-Cost Wireless Home Networks”. In: *2019 10th International Conference on Information, Intelligence, Systems and Applications (IISA)* (Patras, Greece). July 2019, pp. 1–4.

⁹⁶Skiadopoulos, see n. 64, p. 11.

3.4.4 Dominating Sets

Connected dominating sets (CDS) were considered since such a subnetwork corresponds to the optimal information dissemination. It is a hard problem and the aim was to propose a scalable algorithm based on local information.⁹⁷ Part of this work was included in a Ph.D. Thesis.⁹⁸ The particular algorithm was also implemented in a low-cost system to highlight its scalability advantages.^{99,100} This work was further extended and a new algorithm was proposed that used a fixed number of messages (budget) to create the dominating set.¹⁰¹

Information dissemination or collection faces new challenges given UAV (Unmanned Aerial Vehicles). An initial study in this area evaluated the possibilities of using drones to collect data given a terrestrial wireless sensor network.¹⁰² The extension of this work revealed a relation between basic symmetric schemes of the drone's route.¹⁰³ Studying a swarm of drones and experimenting with various paths was the next step.^{104,105}

3.5 Spectrum Analysis

Studying the spectrum of a topology, is an interesting and deep subject that reveals certain properties and sheds light to the particular of various network functions. So far, as part of the information dissemination and particularly, probabilistic flooding, some works have been presented^{106,107,108} that employ spectrum analysis.

The study of facility location and particularly, the case of one median has also been investigated.¹⁰⁹ Service facility location is a challenging problem in the emerging dynamic modern network environments of increased number of users, devices, and supported applications. Under

⁹⁷Skiadopoulos, Giannakis, Oikonomou, Stavrakakis, and Aïssa, see n. 63, p. 11.

⁹⁸Skiadopoulos, see n. 64, p. 11.

⁹⁹Alexandros Zervopoulos, Konstantinos Skiadopoulos, Konstantinos Giannakis, Konstantinos Oikonomou, Vasileios Komianos, and Georgios Tsoumanis. "Constructing Virtual Backbones over Low-Cost Wireless Networks for Smart Tourism Services". In: *2019 10th International Conference on Information, Intelligence, Systems and Applications (IISA)* (Patras, Greece). July 2019, pp. 1–8.

¹⁰⁰Alexandros Zervopoulos, Vasileios Komianos, Konstantinos Skiadopoulos, Georgios Tsoumanis, Athanasios Spiggos, Konstantinos Giannakis, and Konstantinos Oikonomou. "Constructing Minimal Maintenance Virtual Backbones over Low-Cost Wireless Networks". In: *2019 4th South-East Europe Design Automation, Computer Engineering, Computer Networks and Social Media Conference (SEEDA-CECNSM)* (Piraeus, Greece). Sept. 2019, pp. 1–6.

¹⁰¹Konstantinos Skiadopoulos, Athanasios Tsipis, and Konstantinos Oikonomou. "Constructing Budget Connected Dominating Sets in Large-Scale IoT Network Environments". In: *2021 International Balkan Conference on Communications and Networking (BalkanCom)*. Novi Sad, Serbia, Sept. 2021, pp. 75–79.

¹⁰²Konstantinos Skiadopoulos, Konstantinos Giannakis, Konstantinos Oikonomou, Ioannis Stavrakakis, and Sofia Fanarioti. "A Distributed Method to Organize Terrestrial Nodes to Facilitate Short Drone Routes in WSNs". In: *Third International Balkan Conference on Communications and Networking 2019 (BalkanCom'19)*. Skopje, North Macedonia, June 2019.

¹⁰³Konstantinos Skiadopoulos, Konstantinos Giannakis, Athanasios Tsipis, Konstantinos Oikonomou, and Ioannis Stavrakakis. "Impact of Drone Route Geometry on Information Collection in Wireless Sensor Networks". In: *Ad Hoc Networks* 106 (2020), p. 102220.

¹⁰⁴Konstantinos Bezas, Konstantinos Oikonomou, and Georgios Tsoumanis. "A Coverage Path Planning Algorithm for Self-Organizing Drone Swarms". In: *2021 International Balkan Conference on Communications and Networking (BalkanCom)*. Novi Sad, Serbia, Sept. 2021, pp. 122–126.

¹⁰⁵Konstantinos Bezas, Georgios Tsoumanis, Constantinos T Angelis, and Konstantinos Oikonomou. "Coverage Path Planning and Point of Interest Detection Using Autonomous Drone Swarms". In: *Sensors* (2022).

¹⁰⁶Oikonomou, Koufoudakis, and Aïssa, see n. 82, p. 12.

¹⁰⁷Koufoudakis, Oikonomou, Giannakis, and Aïssa, see n. 83, p. 12.

¹⁰⁸Koufoudakis, Oikonomou, Aïssa, and Stavrakakis, see n. 84, p. 13.

¹⁰⁹Konstantinos Oikonomou. "A Spectrum Analysis Approach for the Median Problem in Modern Network Environments". In: *2022 IEEE Symposium on Computers and Communications (ISCC)* (Rhodes, Greece). June 2022.

this perspective, the *median problem* is revisited from a spectrum analysis point of view. More specifically, a *median matrix* depending on the network topology and the traffic requirements of the network nodes is introduced. An analytical investigation of its spectral properties reveals that the minimum elements of its *principal eigenvector* correspond to the solution of the median problem. The smallest eigenvalue is also studied through simulations to demonstrate the effectiveness of the spectrum analysis approach introduced in this paper. Moreover, its relation to a metric related to the robustness of the median solution is investigated, thus shedding further light on the particulars of facility location problems. An application to cloud gaming environments was also investigated.¹¹⁰

A similar spectrum-based approach was also considered for studying the facility location problem using the principal eigenvector of the distance matrix.¹¹¹ An proposed approximation was shown to operate close to the optimal solution.

3.6 Virtual Reality Applications and Network Users

After a successful proposal regarding a funded development project¹¹² about the virtual representation of monuments and other important places of the Ionian Islands in virtual reality, new challenges were introduced. More specifically, the implemented virtual world is expected to be useful for the promotion of the area. However, the increased amount of information and the need for small latency to support multiple users introduce new networking challenges. In order to deal with these challenges, the starting point was the study of these environments concerning the provided quality of service and quality of experience.¹¹³

The various phases (requirements, design and implementation) required to create a large-scale virtual environment focusing on cultural inheritance are presented and studied.¹¹⁴ As large scale virtual worlds may have a negative impact on the user’s experience, suitable routes need to be selected in order to guide the user within a virtual world given its interests.¹¹⁵ An algorithm for creating these routes was proposed inspired by routing in computer networks, in order to assist the virtual reality tour.¹¹⁶ The special case of Corfu (the basis of the Ionian University) and how a new environment of promoting cultural inheritance using these type of approaches

¹¹⁰Tsipis, Fanarioti, Komianos, Sioutas, and Oikonomou, see n. 75, p. 11.

¹¹¹Asterios Papamichail, Athanasios Tsipis, Georgios Tsoumanis, and Konstantinos Oikonomou. “Study of a Proposed Spectral-based Approach for Facility Location in Tree Topologies”. In: *2022 Global Information Infrastructure and Networking Symposium (GIIS) (GIIS’22)*. Argostoli, Greece, Sept. 2022.

¹¹²Ionian Islands Virtual World. [ESPA 2007-2013]. *Role: Co-ordinator on behalf of the Ionian University*. 2012-2015.

¹¹³Vasileios Komianos, Georgios Tsoumanis, Eleni Kavvadia, and Konstantinos Oikonomou. “A Framework for Cultural Heritage Content Organisation, Dissemination and Communication in Large-Scale Virtual Environments”. In: *International Journal of Computational Intelligence Studies* 5.1 (2016), pp. 71–93.

¹¹⁴Vasileios Komianos, Eleni Kavvadia, and Konstantinos Oikonomou. “Efficient and Realistic Cultural Heritage Representation in Large Scale Virtual Environments”. In: *IISA 2014, The 5th International Conference on Information, Intelligence, Systems and Applications* (Chania, Greece). July 2014, pp. 1–6.

¹¹⁵Vasileios Komianos, Eleni Kavvadia, and Konstantinos Oikonomou. “Cultural Heritage Recommendations and User Navigation in Large Scale Virtual Environments”. In: *International Journal of Computational Intelligence Studies* 4.2 (2015), pp. 151–172.

¹¹⁶Vasileios Komianos and Konstantinos Oikonomou. “Constrained Interest-Based Tour Recommendations in Large Scale Cultural Heritage Virtual Environments”. In: *2015 6th International Conference on Information, Intelligence, Systems and Applications (IISA)* (Corfu, Greece). July 2015, pp. 1–6.

was also investigated.^{117,118} This work was part of a Ph.D. thesis.¹¹⁹ Research in the continued considering virtual worlds and education.¹²⁰ An interesting area is about virtual museums¹²¹ and the interaction problems with end users.¹²² The problem of automatic construction of exhibits was also studied when cooperating with available libraries.¹²³ Distributed computing issues were also studying for optimization in mixed reality environments.¹²⁴

3.7 Synchronization in Wireless Sensor Networks

Another research area that its starting point was a development project¹²⁵ was the development of a wireless sensor network that was to be installed in historical buildings for monitoring their structural behavior. There was a need for high accuracy, but the existing wireless technology could not provide for them as the wired could. The approach followed was to develop a sensor network of wired characteristics¹²⁶ and synchronization to take place not in real time but only when the sensed data were about to be processed.¹²⁷ This gave the idea for a new development project¹²⁸ and a measurements synchronization protocol was developed – instead of a clock synchronization one – that allows for sensed data to synchronize on a per hop basis as they arrive at

¹¹⁷Georgios Tsoumanis, Eleni Kavvadia, and Konstantinos Oikonomou. “A v(irtual)-City Implementation for Promoting Cultural Heritage”. In: *International Journal of Computational Intelligence Studies* 4.2 (2015), pp. 173–191.

¹¹⁸Georgios Tsoumanis, Eleni Kavvadia, and Konstantinos Oikonomou. “Changing the Look of a City: The v-Corfu Case”. In: *IISA 2014, The 5th International Conference on Information, Intelligence, Systems and Applications* (Chania, Greece). July 2014, pp. 419–424.

¹¹⁹Vasileios Komianos. “Content Personalization Approaches in Cultural Heritage (Real, Virtual and Mixed) Environments”. Ph.D. Thesis. Ionian University, Nov. 2017.

¹²⁰Evangelos Koutsoumpidis, Vasileios Komianos, and Konstantinos Oikonomou. “Evaluation of Virtual Agents’ Effectiveness in History Class”. In: *The European Journal of Education and Applied Psychology* 4 (2017), pp. 14–29.

¹²¹Vasileios Komianos and Konstantinos Oikonomou. “Adaptive Exhibition Topologies for Personalized Virtual Museums”. In: *The First Future of Heritage Science and Technologies Conference, (Heri-Tech), IOP Conference Series: Materials Science and Engineering* (Florence, Italy). Vol. 364. 1. May 2018, p. 012011.

¹²²Vasileios Komianos, Anastasios Latos, and Konstantinos Oikonomou. “Interaction and Information Communication in Virtual Museums”. In: *The First Future of Heritage Science and Technologies Conference, (Heri-Tech), IOP Conference Series: Materials Science and Engineering* (Florence, Italy). Vol. 364. 1. May 2018, p. 012038.

¹²³Vasileios Komianos and Konstantinos Oikonomou. “A Prototype System for Automatic Design of Virtual Exhibitions Integrating Cultural Assets From Public Repositories”. In: *1st International Workshop on Visual Pattern Extraction and Recognition for Cultural Heritage Understanding (VIPERC 2019)* (Pisa, Italy). Jan. 2019, pp. 107–118.

¹²⁴Athanasios Tsipis, Vasileios Komianos, and Konstantinos Oikonomou. “Distributed Computing Paradigms for Optimization of Mixed Reality Applications in Digital Culture”. In: *DCAC 2021: 3rd International Conference on Digital Culture & Audio Visual Challenges, Interdisciplinary Creativity in Arts and Technology* (Preveza, Greece). May 2021.

¹²⁵S.M.ART.BUIL.T. [Interreg Greece-Italy]. *Role: Technical co-ordinator on behalf of the Ionian University*. 2012-2015.

¹²⁶Konstantinos Oikonomou, George Koufoudakis, Eleni Kavvadia, and Vassilis Chrissikopoulos. “A Wireless Sensor Network Innovative Architecture for Ambient Vibrations Structural Monitoring”. In: *Key Engineering Materials* 628 (2014).

¹²⁷George Koufoudakis, Nikos Skiadopoulos, Emmanouel Magkos, and Konstantinos Oikonomou. “Synchronization Issues in an Innovative Wireless Sensor Network Architecture Monitoring Ambient Vibrations in Historical Buildings”. In: *Key Engineering Materials* 628 (2014).

¹²⁸OLI-Net. [ESPA 2014-2020]. *Role: Co-ordinator on behalf of the Ionian University*. 2017-2020.

the sink node.^{129,130} An application was also developed for the case of historical buildings.^{131,132} Synchronization was also studied for agriculture environments (more in 3.9.5 at p. 21).¹³³

3.8 Energy Consumption in Networks

The importance of energy consumption has already been mentioned for the case of medium access control, taking into account the fact that energy is unnecessarily consumed for obsolete data packets,^{134,135} e.g., those that fail to satisfy certain time constraints. Peer-to-peer networks have also been studied to reduce energy consumption in wireless sensor networks¹³⁶ whereas transition phenomena have also been studied.¹³⁷ Another approach assumed energy harvesting issues.¹³⁸

3.8.1 Traffic Load

Energy consumption is related to load and in order to suppress the various misconceptions that appear in the literature, the problem of the randomness of the node positions was studied.^{139,140} In particular, treating the traffic load of certain areas as an average value is not suitable since it neglects isolated nodes that do exist. Part of this work was included in a Ph.D. Thesis.¹⁴¹

¹²⁹Sofia Fanarioti, Athanasios Tspis, Konstantinos Giannakis, George Koufoudakis, Eleni Christopoulou, Konstantinos Oikonomou, and Ioannis Stavrakakis. “A Proposed Algorithm for Data Measurements Synchronization in Wireless Sensor Networks”. In: *Second International Balkan Conference on Communications and Networking 2018 (BalkanCom’18)*. Podgorica, Montenegro, June 2018.

¹³⁰Konstantinos Skiadopoulos, Athanasios Tspis, Konstantinos Giannakis, George Koufoudakis, Eleni Christopoulou, Konstantinos Oikonomou, George Kormentzas, and Ioannis Stavrakakis. “Synchronization of Data Measurements in Wireless Sensor Networks for IoT Applications”. In: *Ad Hoc Networks* 89 (2019), pp. 47–57.

¹³¹Konstantinos Bezas, Vasileios Komianos, Konstantinos Oikonomou, George Koufoudakis, and Georgios Tsoumanis. “Structural Health Monitoring In Historical Buildings Using A Low Cost Wireless Sensor Network”. In: *2019 4th South-East Europe Design Automation, Computer Engineering, Computer Networks and Social Media Conference (SEEDA-CECNSM)* (Piraeus, Greece). Sept. 2019, pp. 1–4.

¹³²Konstantinos Bezas, Vasileios Komianos, George Koufoudakis, Georgios Tsoumanis, Katerina Kabassi, and Konstantinos Oikonomou. “Structural Health Monitoring in Historical Buildings: A Network Approach”. In: *Heritage* 3.3 (2020), pp. 796–818.

¹³³Alexandros Zervopoulos et al. “Wireless Sensor Network Synchronization for Precision Agriculture Applications”. In: *Agriculture* 10.3 (2020).

¹³⁴Oikonomou and Stavrakakis, “Energy Considerations for Topology-Unaware TDMA MAC Protocols”, see n. 18, p. 5.

¹³⁵Oikonomou and Stavrakakis, “Power Efficiency Analysis for Topology-Unaware TDMA MAC Policies in Ad-Hoc Networks”, see n. 19, p. 5.

¹³⁶Spyros Sioutas, Konstantinos Oikonomou, George Papaloukopoulos, M Xenos, and Yannis Manolopoulos. “Building an Efficient P2P Overlay for Energy-level Queries in Sensor Networks”. In: *Proceedings of the International Conference on Management of Emergent Digital EcoSystems* (Lyon, France). MEDES ’09. ACM, 2009, 54:361–54:368.

¹³⁷Markos Avlonitis, Panagiotis Vlamos, and Konstantinos Oikonomou. “A Space-Time Analytical Model for Energy Consumption in Wireless Sensor Networks”. In: *The Sixth Annual Mediterranean Ad Hoc Networking Workshop (Med-Hoc-Net 2007), Corfu, Greece*. 2007.

¹³⁸Kavvadia, Koufoudakis, and Oikonomou, see n. 79, p. 12.

¹³⁹Apostolos Demertzis and Konstantinos Oikonomou. “Analysis of Concise “Average Load” Definitions in Uniformly Random Deployed Wireless Sensor Networks”. In: *Proceedings of the 11th PErvasive Technologies Related to Assistive Environments Conference*. PETRA ’18. Corfu, Greece: ACM, 2018, pp. 17–22.

¹⁴⁰Apostolos Demertzis and Konstantinos Oikonomou. “Average Load Definition in Random Wireless Sensor Networks: The Traffic Load Case”. In: *Technologies* 6.4 (2018).

¹⁴¹Apostolos Demertzis. “Energy-Aware Routing in Wireless Sensor Networks”. Ph.D. Thesis. Ionian University, June 2019.

3.8.2 Routing

Energy consumption is closely related to the routes that data packets follow and consequently, to the routing policy in the network.^{142,143,144,145} Routing in wireless sensor networks was studied, allowing packets to dynamically choose different routes of less depleted batteries.^{146,147,148} Part of this work was included in a Ph.D. Thesis.¹⁴⁹ Another approach by employing clustering mechanisms was also studied in order to reduce the burden of the network nodes.¹⁵⁰

3.8.3 Sink Placement for Energy Consumption Minimization

Energy consumption is of critical importance in wireless sensor networks. In order to deal with this problem, at the first stage, the problem that was studied referred to the particular location of the sink node, thus the problem was modeled as a facility location one¹⁵¹ and it was proved that the solution of the median is the ideal location for the sink node(s).¹⁵² Part of this work was included in a Ph.D. Thesis.¹⁵³

Research efforts in this particular area continued by proposing an operation framework to increase network lifetime through a dues mode operation: finding the optimal position for the sink node and then exploit it for uniform energy consumption of the network nodes.¹⁵⁴

¹⁴²Apostolos Demertzis and Konstantinos Oikonomou. “Braided Routing Technique to Balance Traffic Load in Wireless Sensor Networks”. In: *International Journal of Monitoring and Surveillance Technologies Research (IJMSTR)* 4.4 (2016), pp. 1–19.

¹⁴³Apostolos Demertzis and Konstantinos Oikonomou. “A Braided Routing Mechanism to Reduce Traffic Load’s Local Variance in Wireless Sensor Networks”. In: *2015 6th International Conference on Information, Intelligence, Systems and Applications (IISA)* (Corfu, Greece). July 2015, pp. 1–6.

¹⁴⁴Apostolos Demertzis and Konstantinos Oikonomou. “Braided Routing Technique to Balance Traffic Load in Wireless Sensor Networks”. In: *Sensor Technology: Concepts, Methodologies, Tools, and Applications*. IGI Global, Mar. 2020. Chap. 40, pp. 837–855.

¹⁴⁵Apostolos Demertzis and Konstantinos Oikonomou. “Avoiding Energy Holes in Wireless Sensor Networks with Non-Uniform Energy Distribution”. In: *IISA 2014, The 5th International Conference on Information, Intelligence, Systems and Applications* (Chania, Greece). July 2014, pp. 138–143.

¹⁴⁶Apostolos Demertzis, Konstantinos Oikonomou, and Ioannis Stavrakakis. “An Adjustable Forwarding Policy Exploiting Path Vulnerability in Wireless Sensor Networks”. In: *Second International Balkan Conference on Communications and Networking 2018 (BalkanCom’18)*. Podgorica, Montenegro, June 2018.

¹⁴⁷Apostolos Demertzis, Konstantinos Oikonomou, and Ioannis Stavrakakis. “Evaluation of a Proposed Minimum Path Impotence Routing Policy in Wireless Sensor Networks”. In: *Ad Hoc Networks* 94 (2019), p. 101928.

¹⁴⁸Demertzis and Oikonomou, “Braided Routing Technique to Balance Traffic Load in Wireless Sensor Networks”, see n. 144.

¹⁴⁹Demertzis, see n. 141, p. 17.

¹⁵⁰Alexandros Zachariadis, Konstantinos Oikonomou, and Georgios Tsoumanis. “Network Lifetime Extension Evaluation of Energy Harvesting and Clustering Approaches in WSNs”. In: *2019 4th South-East Europe Design Automation, Computer Engineering, Computer Networks and Social Media Conference (SEEDA-CECNSM)* (Piraeus, Greece). Sept. 2019, pp. 1–6.

¹⁵¹Oikonomou and Aïssa, see n. 47, p. 8.

¹⁵²Georgios Tsoumanis, Konstantinos Oikonomou, Georgios Koufoudakis, and Sonia Aïssa. “Energy-Efficient Sink Placement in Wireless Sensor Networks”. In: *Computer Networks* 141 (2018), pp. 166–178.

¹⁵³Georgios Tsoumanis. “Energy Consumption Optimization in Wireless Sensor Networks”. Ph.D. Thesis. Ionian University, Sept. 2018.

¹⁵⁴Georgios Tsoumanis, Nikolaos Giannakeas, Alexandros T. Tzallas, Evripidis Glavas, Eleftherios Stergiou, Konstantinos Oikonomou, and Constantinos T. Angelis. “A Lifetime Extension Framework for Wireless Sensor Networks”. In: *2020 43rd International Conference on Telecommunications and Signal Processing (TSP)* (Milan, Italy). July 2020, pp. 260–264.

3.8.4 Recharger Placement for Recharging Distance Minimization

A different approach is recharging the nodes of a wireless sensor network and it was shown that this is once more a facility location problem.^{155,156} An on-demand recharging policy was proposed and studied.¹⁵⁷ Even though it was a distributed one and based on local information, it was performing better than when compared against the existing ones in the literature that are based on global information. Part of this work was included in a Ph.D. Thesis.¹⁵⁸

3.8.5 The Common Facility Location Problem for Sink and Recharger

A mobile recharger that operates on a wireless sensor network aims to keep the average network energy consumption and the distance covered as low as possible. As previously mentioned, the distance covered is minimized when the base of the mobile recharger is located according to the solution of a median problem. In contrast, the average energy consumption is minimized according to the solution of a different median problem. After a detailed study of the first problem, it was shown that its solution depends on the traffic load and topological characteristics. Moreover, it seems that, under certain conditions, the solution to both problems is the same. These analytical results motivate introducing a new recharging policy, simple to implement and based on local information. The simulation results confirm the analytical findings, showing that the solutions of both median problems are identical under certain conditions in a wireless sensor network environment. In addition, the proposed recharge policy is evaluated concerning a well-known policy that utilizes universal knowledge, proving its advantage in extending the life of the network. For both recharging policies, it appears that energy consumption and distance covered are minimized when the mobile recharger is initially working to resolve these median problems.¹⁵⁹

3.9 Experimental IoT Environments and Applications

An important effort involved experimenting with Arduino and various types of low-cost devices. This includes a number of publications that confirm older theoretical approaches.^{160,161}

3.9.1 Ionian University Demo Wireless Network

For further experiments, a wireless sensor network was created in the Ionian University Campus.¹⁶² This is an extensive network of thirty nodes that allows experimentation in a real en-

¹⁵⁵Tsoumanis, Oikonomou, Aïssa, and Stavrakakis, “Recharging Vehicle Distance Minimization in Wireless Sensor Networks”, see n. 48, p. 8.

¹⁵⁶Georgios Tsoumanis, Konstantinos Oikonomou, Sonia Aïssa, and Ioannis Stavrakakis. “A Recharging Distance Analysis for Wireless Sensor Networks”. In: *Ad Hoc Networks* 75-76 (2018), pp. 80–86.

¹⁵⁷Georgios Tsoumanis, Konstantinos Oikonomou, Sonia Aïssa, and Ioannis Stavrakakis. “Performance Evaluation of a Proposed On-Demand Recharging Policy in Wireless Sensor Networks”. In: *2018 IEEE 19th International Symposium on “A World of Wireless, Mobile and Multimedia Networks” (WoWMoM) (IEEE WoWMoM 2018)*. Chania, Crete, Greece, June 2018, pp. 14–19.

¹⁵⁸Tsoumanis, “Energy Consumption Optimization in Wireless Sensor Networks”, see n. 153, p. 18.

¹⁵⁹Georgios Tsoumanis, Konstantinos Oikonomou, Sonia Aïssa, and Ioannis Stavrakakis. “Energy and Distance Optimization in Rechargeable Wireless Sensor Networks”. In: *IEEE Transactions on Green Communications and Networking* 5.1 (Mar. 2021), pp. 378–391.

¹⁶⁰Alvanou, Skiadopoulos, Giannakis, Oikonomou, and Tsoumanis, see n. 95, p. 13.

¹⁶¹Zervopoulos, Skiadopoulos, Giannakis, Oikonomou, Komianos, and Tsoumanis, see n. 99, p. 14.

¹⁶²Asterios Papamichail, Aikaterini Georgia Alvanou, Alexandros Zervopoulos, Konstantinos Bezas, Spiridon Vergis, George Koufoudakis, Konstantinos Oikonomou, and Georgios Tsoumanis. “Description of the Ionian University’s Campus Wireless Network Testbed Infrastructure”. In: *2019 4th South-East Europe Design Automation, Computer Engineering, Computer Networks and Social Media Conference (SEEDA-CECNSM)* (Piraeus, Greece). Sept. 2019, pp. 1–4.

environment as these buildings are historical features (solid walls, inner courtyards, etc.).¹⁶³ This environment is suitable for various types of experiments involving wireless networks.^{164,165,166,167}

3.9.2 Vehicular Environments

Medium access control (MAC) is a challenging problem in vehicular environments due to a constantly changing topology due to vehicle's mobility and stringent delay requirements, especially for safety-related applications (e.g., for vehicular-to-vehicular communication). Consequently, topology-independent TDMA MAC policies that guarantee a number of successful transmissions per frame independently of the underlying topology, can be regarded as a suitable choice for the particular vehicular environment.^{168,169} Apparently, investigating suitable TDMA MAC policies is a key research area in vehicular environments.^{170,171,172} Another interesting aspect is offloading data in a smart city environment.¹⁷³

3.9.3 UAV Environments

The recent technological evolution of drones along with the constantly growing maturity of its commercialization, has led to the emergence of novel drone-based applications within the field of wireless sensor networks for information collection purposes. In such settings, especially when deployed in outdoor environments with limited external control, energy consumption and robustness are challenging problems for the system's operation. Offloading a wireless sensor network is a first aspect to be studied.¹⁷⁴ Further research in the area revealed the importance of symmetry regarding the routes followed by a drone.¹⁷⁵ The case of a swarm of drones is also investigated¹⁷⁶ as well as fairness issues.¹⁷⁷ Considering limited amount of energy for a particular environment where a budget is initially allowed, a backbone network can be constructed as the route of a drone.¹⁷⁸ Autonomous navigation using deep learning was also investigated.¹⁷⁹

¹⁶³Aikaterini Georgia Alvanou et al. "CaBIUs: Description of the Enhanced Wireless Campus Testbed of the Ionian University". In: *Electronics* 9.3 (2020).

¹⁶⁴Alvanou, Skiadopoulos, Giannakis, Oikonomou, and Tsoumanis, see n. 95, p. 13.

¹⁶⁵Bezas, Komianos, Oikonomou, Koufoudakis, and Tsoumanis, see n. 131, p. 17.

¹⁶⁶Bezas, Komianos, Koufoudakis, Tsoumanis, Kabassi, and Oikonomou, see n. 132, p. 17.

¹⁶⁷Stylidou, Zervopoulos, Alvanou, Koufoudakis, Tsoumanis, and Oikonomou, see n. 87, p. 13.

¹⁶⁸Dragonas, Oikonomou, and Stavrakakis, "A Topology-Independent TDMA MAC Policy for Safety Applications in Vehicular Networks", see n. 28, p. 6.

¹⁶⁹Dragonas, Oikonomou, and Stavrakakis, "A Disjoint Frame Topology-Independent TDMA MAC Policy for Safety Applications in Vehicular Networks", see n. 29, p. 6.

¹⁷⁰Dragonas, Tsoumanis, and Oikonomou, "A Refined Topology-Independent Probabilistic TDMA MAC Policy for Ad Hoc Networks", see n. 22, p. 6.

¹⁷¹Dragonas, Tsoumanis, and Oikonomou, "A Probabilistic Refined Policy For Topology Independent Medium Access Control In Ad Hoc Network Environments", see n. 23, p. 6.

¹⁷²Oikonomou and Stavrakakis, "Analysis of a Probabilistic Topology-Unaware TDMA MAC Policy for Ad Hoc Networks", see n. 13, p. 5.

¹⁷³Spiridon Vergis, Vasileios Komianos, Georgios Tsoumanis, Athanasios Tshipis, and Konstantinos Oikonomou. "A Low-Cost Vehicular Traffic Monitoring System Using Fog Computing". In: *Smart Cities* 3.1 (2020), pp. 138–156.

¹⁷⁴Skiadopoulos, Giannakis, Oikonomou, Stavrakakis, and Fanarioti, see n. 102, p. 14.

¹⁷⁵Skiadopoulos, Giannakis, Tshipis, Oikonomou, and Stavrakakis, see n. 103, p. 14.

¹⁷⁶Bezas, Oikonomou, and Tsoumanis, see n. 104, p. 14.

¹⁷⁷Konstantinos Bezas, Georgios Tsoumanis, Kyriakos Koritsoglou, Konstantinos Oikonomou, Alexandros T Tzallas, Nikolaos Giannakeas, Markos Tshipouras, and Constantinos T Angelis. "A Fairness-aware Coverage Algorithm for Drone Swarms". In: *2022 7th South-East Europe Design Automation, Computer Engineering, Computer Networks and Social Media Conference (SEEDA-CECNSM)* (Ioannina, Greece). 2022.

¹⁷⁸Skiadopoulos, Tshipis, and Oikonomou, see n. 101, p. 14.

¹⁷⁹Andreas Karatzas, Aristeidis Karras, Christos Karras, Konstantinos C. Giotopoulos, Konstantinos Oikonomou, and Spyros Sioutas. "On Autonomous Drone Navigation Using Deep Learning and an Intelligent

3.9.4 Smart City and Smart Tourism

An effort to study traffic within a city (smart city) was created to record the load with devices installed in cars and which were connected to a cloud computing network for further data processing.^{180,181,182} In the same way, experimentation took place to create low-cost infrastructure networks (backbone)¹⁸³ for applications in smart tourism.¹⁸⁴ The issue of the health of historic buildings was also studied through a relevant experimental application.^{185,186} Theoretical approaches were also confirmed in this real environment.¹⁸⁷ Service issues for metropolitan networks from a different perspective were also studied.¹⁸⁸

3.9.5 Smart Agriculture

Another application that was emphasized is smart agriculture and especially the cultivation in olive groves. A relevant architecture was proposed and various experiments were performed on the use of cloud computing architectures.^{189,190} In this way it appeared that it is possible to optimize production. Another interesting application is the monitoring of areas to avoid fires.¹⁹¹

Due to the rapid urbanization in many developing countries along with other major factors, such as global warming, the agriculture industries are striving to cope nowadays more than ever. A published chapter¹⁹² gives a better insight on how the Information Communications Technologies and the development of Internet of Things applications can be used in the field of agriculture. While presenting general information regarding issues faced by these industries, the chapter focuses on analyzing the various low-cost hardware components (sensors, processing units, etc.), a simple Wireless Sensor Network synchronization method and a cloud/fog architecture suitable for environmental monitoring and agricultural applications. The effectiveness of the synchronization process is evaluated with experiments previously conducted on an olive grove. Likewise, the cloud/fog architecture is evaluated based on previous experimental runs led by other researchers. The results of both approaches are briefly presented and analyzed. The performance evaluation metrics used to outline their effectiveness are the Round Trip Time of a data packet

Rainbow DQN Agent”. In: *Intelligent Data Engineering and Automated Learning – IDEAL 2022*. Ed. by Hujun Yin, David Camacho, and Peter Tino. Springer International Publishing, 2022, pp. 134–145.

¹⁸⁰Spiridon Vergis, Vasileios Komianos, Georgios Tsoumanis, Athanassios Spiggos, and Konstantinos Oikonomou. “Implementation of a Low-Cost Vehicle Traffic Monitoring System in the Town of Corfu”. In: *2019 4th South-East Europe Design Automation, Computer Engineering, Computer Networks and Social Media Conference (SEEDA-CECNSM)* (Piraeus, Greece). Sept. 2019, pp. 1–6.

¹⁸¹Vergis, Komianos, Tsoumanis, Tsipis, and Oikonomou, see n. 173, p. 20.

¹⁸²Spiridon Vergis, Georgios Tsoumanis, and Konstantinos Oikonomou. “A Proposed Multi-Head Clustering Algorithm for VANET Environments”. In: *2021 6th South-East Europe Design Automation, Computer Engineering, Computer Networks and Social Media Conference (SEEDA-CECNSM)* (Piraeus, Greece). Sept. 2021, pp. 1–8.

¹⁸³Zervopoulos, Komianos, Skiadopoulos, Tsoumanis, Spiggos, Giannakis, and Oikonomou, see n. 100, p. 14.

¹⁸⁴Zervopoulos, Skiadopoulos, Giannakis, Oikonomou, Komianos, and Tsoumanis, see n. 99, p. 14.

¹⁸⁵Bezas, Komianos, Oikonomou, Koufoudakis, and Tsoumanis, see n. 131, p. 17.

¹⁸⁶Bezas, Komianos, Koufoudakis, Tsoumanis, Kabassi, and Oikonomou, see n. 132, p. 17.

¹⁸⁷Stylidou, Zervopoulos, Alvanou, Koufoudakis, Tsoumanis, and Oikonomou, see n. 87, p. 13.

¹⁸⁸Adamantia Pateli, Andreas Floros, Konstantinos Oikonomou, and Emmanouil Magkos. “Corfunet: A Mesh Network Providing Wireless Services at Metropolitan Level”. In: *Proceedings of the IADIS International Conference on Wireless Applications and Computing 2008* (Amsterdam, The Netherlands). July 2008, pp. 22–24.

¹⁸⁹Tsipis, Papamichail, Koufoudakis, Tsoumanis, Polykalas, and Oikonomou, see n. 59, p. 10.

¹⁹⁰Zervopoulos et al., see n. 133, p. 17.

¹⁹¹Tsipis, Papamichail, Angelis, Koufoudakis, Tsoumanis, and Oikonomou, see n. 60, p. 10.

¹⁹²Ioannis Angelis et al. “Smart Agriculture: A Low-Cost Wireless Sensor Network Approach”. In: *Information and Communication Technologies for Agriculture—Theme I: Sensors*. Ed. by Dionysis D. Bochtis, Maria Lampridi, George P. Petropoulos, Yiannis Ampatzidis, and Panos Pardalos. Cham: Springer International Publishing, 2022, pp. 139–172.

and the packet load on every time step. A brief review of the key components of each of the aforementioned subjects is presented and possible future directions are provided.

3.10 Various Research Topics (Security, Design, Social Networks, Education)

Various research topics have been studied such as privacy and security issues,¹⁹³ modeling a network of human relations as a time-varying graph¹⁹⁴ and privacy protection in peer-to-peer networks.¹⁹⁵ Another effort is to employ small robotics to improve teaching¹⁹⁶ as a result from a summer school.¹⁹⁷ Literature review for STEM education was also been published.¹⁹⁸ The study effort for the development of a low-cost sensor network for the monitoring of pollution in the Ionian Sea was also considered.¹⁹⁹ The area of federated learning in edge devices is also investigated.²⁰⁰

4 Additional Research Activities

The following is a list of various additional research activities of Prof. K. Oikonomou and are summarized as follows:

- 4.1 Synopsis of Research Interests
- 4.2 List of Selected Publications
- 4.3 Best Paper Awards
- 4.4 Selected Collaborations (Number of Publications: 33)
 - 4.4.1 KAUST / University of Quebec (INRS, Montreal), 2011-today
 - 4.4.2 University of Glasgow, 2011-2014
 - 4.4.3 Boston University, 2007-2014
- 4.5 Ph.D. Supervision
 - 4.5.1 Graduates (7)

¹⁹³Emmanouil Magkos, Panayiotis Kotzanikolaou, Spyros Sioutas, and Konstantinos Oikonomou. “A Distributed Privacy-Preserving Scheme for Location-Based Queries”. In: *2010 IEEE International Symposium on A World of Wireless, Mobile and Multimedia Networks (WoWMoM)* (Montreal, Canada). June 2010, pp. 1–6.

¹⁹⁴Konstantinos Oikonomou, Afroditi Loukidou, and Spyros Sioutas. “A Study of a Time-Graph Friendship Model”. In: *2011 IEEE International Symposium on a World of Wireless, Mobile and Multimedia Networks* (Lucca, Italy). June 2011, pp. 1–6.

¹⁹⁵Dimitrios Tsohis, Spyros Sioutas, Alexandros Panaretos, Ioannis Karydis, and Konstantinos Oikonomou. “Decentralized Digital Content Exchange and Copyright Protection via P2P Networks”. In: *2011 IEEE Symposium on Computers and Communications (ISCC)* (Corfu, Greece). June 2011, pp. 1056–1061.

¹⁹⁶Spyros Polykalas, George Prezerakos, Kyriakos Vlachos, and Konstantinos Oikonomou. “Introduction to Robotics for Novice Users: A Case Study from Summer Schools in Greece”. In: *European Journal of Engineering Research and Science CIE* (2018), pp. 25–29.

¹⁹⁷[Principles of Informatics - Applications in Robotics]. 19-23 June 2017, Corfu, Greece. *Organizer of Summer School Principles of Informatics - Applications in Robotics organized by the Department of Informatics, Ionian University*. June 2017.

¹⁹⁸Konstantina Maidatsi, Eleni Christopoulou, and Konstantinos Oikonomou. “Using STEM Learning Concepts with IoT Technology on the Road of Education for Sustainability: A Short Literature Review”. In: *2022 7th South-East Europe Design Automation, Computer Engineering, Computer Networks and Social Media Conference (SEEDA-CECNSM)* (Ioannina, Greece). 2022.

¹⁹⁹Georgios Tsoumanis, George Koufoudakis, Konstantinos Oikonomou, Markos Avlonits, and Nikos Varotsis. “A Low-Cost Surface Wireless Sensor Network for Pollution Monitoring in the Ionian Sea”. In: *12th Panhellenic Symposium of Oceanography & Fisheries* (Corfu, Greece). Abstract. May 2018.

²⁰⁰Aristeidis Karras, Christos Karras, Konstantinos C. Giotopoulos, Dimitrios Tsohis, Konstantinos Oikonomou, and Spyros Sioutas. “Peer to Peer Federated Learning: Towards Decentralized Machine Learning on Edge Devices”. In: *2022 7th South-East Europe Design Automation, Computer Engineering, Computer Networks and Social Media Conference (SEEDA-CECNSM)* (Ioannina, Greece). 2022.

- 4.5.2 Ph.D. Students (5)
- 4.5.3 Member of Ph.D. Advisory/Examination Committees (10)
- 4.6 Editorials
 - 4.6.1 Journals (7)
 - 4.6.2 Conference Proceedings (3)
- 4.7 Main Scientific Talks (9)
- 4.8 Reviews
- 4.9 Conference Organization (9)

4.1 Synopsis of Research Interests

Study and analysis of issues related to the placement of services in dynamic large-scale network environments. Study and analysis of issues related to information dissemination in large unstructured environments. Complexity and scalability issues in modern network environments. Social networking issues, modeling, analysis and study. Study and development of media access protocols and routing protocols in ad hoc and mesh networks. Energy consumption analysis in wireless sensor networks. Use of algebraic graph theory techniques to model the behavior of wireless networks. Performance issues in multimedia networks to support big data multimedia applications. Synchronization issues in wireless sensor networks. Cloud gaming issues. Service placement issues in cloud computing environments.

4.2 List of Selected Publications

The following is a list of selected publications that have been published in major conferences and peer-reviewed journals.

- Konstantinos Oikonomou. “A Spectrum Analysis Approach for the Median Problem in Modern Network Environments”. In: *2022 IEEE Symposium on Computers and Communications (ISCC)* (Rhodes, Greece). June 2022.
- Konstantinos Oikonomou, George Koufoudakis, Sonia Aïssa, and Ioannis Stavrakakis. “Probabilistic Flooding Performance Analysis Exploiting Graph Spectra Properties”. In: *IEEE/ACM Transactions on Networking* (2022), pp. 1–14.
- Athanasios Tsipis and Konstantinos Oikonomou. “Joint optimization of social interactivity and server provisioning for interactive games in edge computing”. In: *Computer Networks* 212 (2022), p. 109028.
- “Player Assignment in MEC Gaming for Social Interactivity and Server Provisioning Optimization”. In: *2021 IEEE Symposium on Computers and Communications (ISCC)* (Athens, Greece). Sept. 2021, pp. 1–7.
- Georgios Tsoumanis, Konstantinos Oikonomou, Sonia Aïssa, and Ioannis Stavrakakis. “Energy and Distance Optimization in Rechargeable Wireless Sensor Networks”. In: *IEEE Transactions on Green Communications and Networking* 5.1 (Mar. 2021), pp. 378–391.
- Konstantinos Skiadopoulos, Athanasios Tsipis, Konstantinos Giannakis, George Koufoudakis, Eleni Christopoulou, Konstantinos Oikonomou, George Kormentzas, and Ioannis Stavrakakis. “Synchronization of Data Measurements in Wireless Sensor Networks for IoT Applications”. In: *Ad Hoc Networks* 89 (2019), pp. 47–57.
- George Koufoudakis, Konstantinos Oikonomou, Sonia Aïssa, and Ioannis Stavrakakis. “Analysis of Spectral Properties for Efficient Coverage Under Probabilistic Flooding”. In: *2018 IEEE 19th International Symposium on A World of Wireless, Mobile and Multimedia Networks (WoWMoM) (IEEE WoWMoM 2018)*. Chania, Crete, Greece, June 2018, pp. 1–9.

- Konstantinos Skiadopoulos, Konstantinos Giannakis, Konstantinos Oikonomou, Ioannis Stavrakakis, and Sonia Aïssa. “Distributed Construction of d-Hop Connected Dominating Sets for Wireless Sensor Networks”. In: *2018 IEEE Global Communications Conference (GLOBECOM)*. Dec. 2018, pp. 1–7.
- Georgios Smaragdakis, Nikolaos Laoutaris, Konstantinos Oikonomou, Ioannis Stavrakakis, and Azer Bestavros. “Distributed Server Migration for Scalable Internet Service Deployment”. In: *IEEE/ACM Transactions on Networking* 22.3 (June 2014), pp. 917–930.
- Fung Po Tso, Konstantinos Oikonomou, Eleni Kavvadia, and Dimitrios Pezaros. “Scalable Traffic-Aware Virtual Machine Management for Cloud Data Centers”. In: *2014 IEEE 34th International Conference on Distributed Computing Systems (ICDCS)* (Tamilaldu, India). June 2014, pp. 238–247.
- Konstantinos Oikonomou and Ioannis Stavrakakis. “Scalable Service Migration in Autonomic Network Environments”. In: *IEEE Journal on Selected Areas in Communications* 28.1 (Jan. 2010), pp. 84–94.
- Nikolaos Laoutaris, Georgios Smaragdakis, Konstantinos Oikonomou, Ioannis Stavrakakis, and Azer Bestavros. “Distributed Placement of Service Facilities in Large-Scale Networks”. In: *IEEE INFOCOM 2007 - 26th IEEE International Conference on Computer Communications* (Barcelona, Spain). May 2007, pp. 2144–2152.
- Konstantinos Oikonomou and Ioannis Stavrakakis. “Energy Considerations for Topology-Unaware TDMA MAC Protocols”. In: *Ad Hoc Networks* 4.3 (2006), pp. 359–379.
- “Power Efficiency Analysis for Topology-Unaware TDMA MAC Policies in Ad-Hoc Networks”. In: *Proceedings of the 38th Annual Hawaii International Conference on System Sciences (HICSS 2005)* (Big Island, Hawaii). Jan. 2005, 287b–287b.
- “Analysis of a Probabilistic Topology-Unaware TDMA MAC Policy for Ad Hoc Networks”. In: *IEEE Journal on Selected Areas in Communications* 22.7 (Sept. 2004), pp. 1286–1300.
- Konstantinos Oikonomou, Athanasios Vaios, Sebastien Simoens, Pietro Pellati, and Ioannis Stavrakakis. “A Centralized Ad-Hoc Network Architecture (CANA) Based on Enhanced Hiper-LAN/2”. In: *14th IEEE Proceedings on Personal, Indoor and Mobile Radio Communications, 2003. PIMRC 2003*. (Beijing, China). Vol. 2. Sept. 2003, pp. 1336–1340.

4.3 Best Paper Awards

- 2021 Best Paper Award from 2021 IEEE Symposium on Computers and Communications (ISCC) for paper:
Athanasios Tsipis and Konstantinos Oikonomou. “Player Assignment in MEC Gaming for Social Interactivity and Server Provisioning Optimization”. In: *2021 IEEE Symposium on Computers and Communications (ISCC)* (Athens, Greece). Sept. 2021, pp. 1–7
- 2005 Best Paper Award from Proceedings of the 38th Annual Hawaii International Conference on System Sciences (HICSS 2005) for paper:
Konstantinos Oikonomou and Ioannis Stavrakakis. “Power Efficiency Analysis for Topology-Unaware TDMA MAC Policies in Ad-Hoc Networks”. In: *Proceedings of the 38th Annual Hawaii International Conference on System Sciences (HICSS 2005)* (Big Island, Hawaii). Jan. 2005, 287b–287b

4.4 Selected Collaborations (Number of Publications: 33)

The following are the most essential international research-oriented collaborations as well as the corresponding publications.

4.4.1 KAUST / University of Quebec (INRS, Montreal), 2011-today, Prof. Sonia Aïssa

- Konstantinos Oikonomou, George Koufoudakis, Sonia Aïssa, and Ioannis Stavrakakis. “Probabilistic Flooding Performance Analysis Exploiting Graph Spectra Properties”. In: *IEEE/ACM Transactions on Networking* (2022), pp. 1–14.
- Georgios Tsoumanis, Konstantinos Oikonomou, Sonia Aïssa, and Ioannis Stavrakakis. “Energy and Distance Optimization in Rechargeable Wireless Sensor Networks”. In: *IEEE Transactions on Green Communications and Networking* 5.1 (Mar. 2021), pp. 378–391.
- George Koufoudakis, Konstantinos Oikonomou, Sonia Aïssa, and Ioannis Stavrakakis. “Analysis of Spectral Properties for Efficient Coverage Under Probabilistic Flooding”. In: *2018 IEEE 19th International Symposium on A World of Wireless, Mobile and Multimedia Networks (WoWMoM) (IEEE WoWMoM 2018)*. Chania, Crete, Greece, June 2018, pp. 1–9.
- George Koufoudakis, Konstantinos Oikonomou, Konstantinos Giannakis, and Sonia Aïssa. “Probabilistic Flooding Coverage Analysis for Efficient Information Dissemination in Wireless Networks”. In: *Computer Networks* 140 (2018), pp. 51–61.
- Konstantinos Skiadopoulos, Konstantinos Giannakis, Konstantinos Oikonomou, Ioannis Stavrakakis, and Sonia Aïssa. “Distributed Construction of d-Hop Connected Dominating Sets for Wireless Sensor Networks”. In: *2018 IEEE Global Communications Conference (GLOBECOM)*. Dec. 2018, pp. 1–7.
- Georgios Tsoumanis, Konstantinos Oikonomou, Sonia Aïssa, and Ioannis Stavrakakis. “A Recharging Distance Analysis for Wireless Sensor Networks”. In: *Ad Hoc Networks* 75-76 (2018), pp. 80–86.
- “Performance Evaluation of a Proposed On-Demand Recharging Policy in Wireless Sensor Networks”. In: *2018 IEEE 19th International Symposium on “A World of Wireless, Mobile and Multimedia Networks” (WoWMoM) (IEEE WoWMoM 2018)*. Chania, Crete, Greece, June 2018, pp. 14–19.
- Georgios Tsoumanis, Konstantinos Oikonomou, Georgios Koufoudakis, and Sonia Aïssa. “Energy-Efficient Sink Placement in Wireless Sensor Networks”. In: *Computer Networks* 141 (2018), pp. 166–178.
- Georgios Tsoumanis, Konstantinos Oikonomou, Sonia Aïssa, and Ioannis Stavrakakis. “Recharging Vehicle Distance Minimization in Wireless Sensor Networks”. In: *BalkanCom 2017, First International Balkan Conference on Communications and Networking, Tirana, Albania* (Tirana, Albania). June 2017.
- Eleni Kavvadia, Spyros Sagiadinos, Konstantinos Oikonomou, Giorgos Tsioutsoulouklis, and Sonia Aïssa. “Elastic Virtual Machine Placement in Cloud Computing Network Environments”. In: *Computer Networks* 93.Part 3 (2015). Cloud Networking and Communications II, pp. 435–447.
- Konstantinos Oikonomou and Sonia Aïssa. “Dynamic Sink Assignment for Efficient Energy Consumption in Wireless Sensor Networks”. In: *2012 IEEE Wireless Communications and Networking Conference (WCNC)* (Paris, France). Apr. 2012, pp. 1876–1881.
- Konstantinos Oikonomou, George Koufoudakis, and Sonia Aïssa. “Probabilistic Flooding Coverage Analysis in Large Scale Wireless Networks”. In: *2012 19th International Conference on Telecommunications (ICT)* (Jounieh, Lebanon). Apr. 2012, pp. 1–6.
- Konstantinos Oikonomou, Giorgos Tsioutsoulouklis, and Sonia Aïssa. “Scalable Facility Placement for Communication Cost Reduction in Wireless Networks”. In: *2012 IEEE International Conference on Communications (ICC)* (Ottawa, Canada). June 2012, pp. 5118–5123.

4.4.2 University of Glasgow, 2011-2014, Prof. Dimitrios Pezaros

Fung Po Tso, Konstantinos Oikonomou, Eleni Kavvadia, and Dimitrios Pezaros. “Scalable Traffic-Aware Virtual Machine Management for Cloud Data Centers”. In: *2014 IEEE 34th International Conference on Distributed Computing Systems (ICDCS)* (Tamilnadu, India). June 2014, pp. 238–247.

Fung Po Tso, Gregg Hamilton, Konstantinos Oikonomou, and Dimitrios Pezaros. “Implementing Scalable, Network-Aware Virtual Machine Migration for Cloud Data Centers”. In: *2013 IEEE Sixth International Conference on Cloud Computing* (Santa Clara, USA). June 2013, pp. 557–564.

4.4.3 Boston University, 2007-2014, Prof. Azer Bestavros, Prof. George Smaragdakis

Georgios Smaragdakis, Nikolaos Laoutaris, Konstantinos Oikonomou, Ioannis Stavrakakis, and Azer Bestavros. “Distributed Server Migration for Scalable Internet Service Deployment”. In: *IEEE/ACM Transactions on Networking* 22.3 (June 2014), pp. 917–930.

Nikolaos Laoutaris, Georgios Smaragdakis, Konstantinos Oikonomou, Ioannis Stavrakakis, and Azer Bestavros. “Distributed Placement of Service Facilities in Large-Scale Networks”. In: *IEEE INFOCOM 2007 - 26th IEEE International Conference on Computer Communications* (Barcelona, Spain). May 2007, pp. 2144–2152.

4.5 Ph.D. Supervision

He has supervised 7 completed doctoral dissertations and is currently at the Ionian University under the direct supervision of 5 Ph.D. candidates. He has also participated as an ordinary member in 10 three-member advisory committees and seven-member examination committees of doctoral dissertations.

4.5.1 Graduates (7)

So far, 7 doctoral dissertations have been completed under his supervision. These study issues are related to the placement of services in cloud network environments,²⁰¹ routes suitable for large-scale virtual world environments,²⁰² energy efficiency in sensor networks,²⁰³ information dissemination by analysis of algebraic graph theory,²⁰⁴ energy consumption and routing in wireless sensor networks,²⁰⁵ information dissemination employing random walkers,²⁰⁶ and cloud gaming.²⁰⁷

Athanasios Tsipis. “Network Resource Optimization in Cloud Computing Environments”. Ph.D. Thesis. Ionian University, Jan. 2021.

Apostolos Demertzis. “Energy-Aware Routing in Wireless Sensor Networks”. Ph.D. Thesis. Ionian University, June 2019.

George Koufoudakis. “Information Dissemination in Structured and Unstructured Networks”. Ph.D. Thesis. Ionian University, Feb. 2019.

²⁰¹Kavvadia, see n. 54, p. 10.

²⁰²Komianos, see n. 119, p. 16.

²⁰³Tsoumanis, “Energy Consumption Optimization in Wireless Sensor Networks”, see n. 153, p. 18.

²⁰⁴Koufoudakis, see n. 85, p. 13.

²⁰⁵Demertzis, see n. 141, p. 17.

²⁰⁶Skiadopoulos, see n. 64, p. 11.

²⁰⁷Tsipis, see n. 69, p. 11.

Konstantinos Skiadopoulos. “Information Dissemination and Dominating Sets on Wireless Sensor Networks”. Text in greek. Ph.D. Thesis. Ionian University, Dec. 2019.

Georgios Tsoumanis. “Energy Consumption Optimization in Wireless Sensor Networks”. Ph.D. Thesis. Ionian University, Sept. 2018.

Eleni Kavvadia. “Virtual Machine Placement for Supporting Network Cloud Services”. Text in greek. Ph.D. Thesis. Ionian University, June 2017.

Vasileios Komianos. “Content Personalization Approaches in Cultural Heritage (Real, Virtual and Mixed) Environments”. Ph.D. Thesis. Ionian University, Nov. 2017.

4.5.2 Ph.D. Students (5)

At the moment 5 doctoral dissertations are in progress under the supervision of Prof. K. Oikonomou, which are the following:

Alexandros Zervopoulos. “Resource Optimization in Softwarized-Virtualized Networking Environments”. Ph.D. Candidate. Ionian University, 2021.

Asterios Papamichail. “Performance and Energy Consumption Analysis in the Industrial Internet of Things”. Ph.D. Candidate. Ionian University, 2021.

Ioannis Angelis. “Optimization of Transfer Protocols for the Satellite Internet of Things”. Ph.D. Candidate. Ionian University, 2021.

Konstantina Maidatsi. “Exploiting the Internet of Things in STEM Education: Interconnected Devices and Environmental Education”. Ph.D. Candidate. Ionian University, 2020.

Vasileios Dragonas. “Medium Access Policies for Vehicular Networks”. Ph.D. Candidate. Ionian University, 2017.

4.5.3 Member of Ph.D. Advisory/Examination Committees (10)

He has also contributed as a member of Ph.D. Advisory and Examination Committees, without supervising, in the following successfully completed doctoral dissertations.

Akrivi Krouska. “A Novel Social Network Incorporating Intelligent Techniques for Personalized Collaborative Learning in Adult Education”. Supervisor: Prof. Maria Virvou. Ph.D. Thesis. University of Piraeus, 2019.

Dimitrios Traperas. “Visual and Sonic Perception of Hyperspaces”. Supervisor: Prof. Nikos Kanellopoulos. Ph.D. Thesis. Ionian University, 2019.

Emmanouil Skondras. “Performance Analysis and Optimization of Next Generation Wireless Networks”. Supervisor: Prof. Dimitrios D. Vergados. Ph.D. Thesis. University of Piraeus, 2019.

Spiridoula Margariti. “Analysis, Modeling and Simulation of Search in Complex Dynamic Networks”. Supervisor: Prof. Vassileios Dimakopoulos. Ph.D. Thesis. University of Ioannina, 2017.

Alexandros Panaretos. “Efficient Query Processing in Distributed Database Systems”. Supervisor: Prof. Spyros Sioutas. Ph.D. Thesis. Ionian University, 2015.

Leonidas Tzevelekas. “Study of Efficient Algorithms for Topology Control and Information Dissemination/extraction in Large Scale Wireless Sensor Networks”. Supervisor: Prof. Ioannis Stavrakakis. Ph.D. Thesis. National and Kapodistrian University of Athens, 2010.

Dimitrios Kogias. “Study and Design of Algorithms for Information Dissemination in Unstructured Environments”. Supervisor: Prof. Ioannis Stavrakakis. Ph.D. Thesis. National and Kapodistrian University of Athens, 2010.

Georgios Karopoulos. “Secure Mobile Multimedia Over All-IP Wireless Heterogeneous Networks”. Supervisor: Prof. Stefanos Gritzalis. Ph.D. Thesis. Aegean university, 2010.

Athanassios Vaios. “Incorporation of the Short-Range Multi-Hop Communication Model in Infrastructure-based Wireless Local Area Networks”. Supervisor: Prof. Ioannis Stavrakakis. Ph.D. Thesis. National and Kapodistrian University of Athens, 2008.

Konstantinos Vassilakis. “Content Distribution Support in Modern Wireless and Wired Networks”. Supervisor: Prof. Ioannis Stavrakakis. Ph.D. Thesis. National and Kapodistrian University of Athens, 2008.

4.6 Editorials

There is an ongoing editing project with the following being the most important.

4.6.1 Journals (7)

Since January 2019 Prof. K. Oikonomou is a Member of the Editorial Board of the Computer Networks journal (Elsevier) and the Journal on Future and Evolving Technologies of the International Telecommunication Union (ITU) in 2020. He has also taken on the role of Guest Editor for various magazines. The full list is as follows:

[Computer Networks-Elsevier]. *Member of the Editorial Board*. 2019-today.

[Future Internet-MDPI]. *Guest Editor of Special Issue: Network Cost Reduction in Cloud/Fog Computing Environments*. 2019-2020.

[Journal on Future and Evolving Technologies-ITU]. *Member of the Editorial Board*. 2020-today.

[Sensors-MDPI]. *Guest Editor of Special Issue: Lifetime Extension Framework for Wireless Sensor Networks*. 2021-2022.

[Technologies-MDPI]. *Guest Editor of Special Issue: Networking, Computing and Immersive Technologies for Smart Environments*. 2020-2021.

[Future Internet-MDPI]. *Guest Editor of Special Issue: Network Cost Reduction in Cloud and Fog Computing Environments*. 2022.

[Journal on Future and Evolving Technologies-ITU]. *Guest Editor of Special Issue: Emerging Trends and Applications in Future Communication Networks*. 2022.

4.6.2 Conference Proceedings (3)

In the context of conferences in which Prof. K. Oikonomou had the role of organizer, the following 3 volumes have been published, which essentially include the minutes of the conferences.

Maria Virvou, Fumihiro Kumeno, and Konstantinos Oikonomou. *Knowledge-Based Software Engineering: 2018 - 2019*. Springer, 2018.

Timos Sellis and Konstantinos Oikonomou. *Algorithmic Aspects of Cloud Computing*. Springer, 2017.

Andrea Passarella and Konstantinos Oikonomou. *Special Section on Autonomous and Opportunistic Communications*. Elsevier, 2010.

4.7 Main Scientific Talks (9)

He has been invited and has given scientific lectures of which the 9 most important are the following:

[Competiveness Issues for Corfu in 2042]. 21-23 October 2022, Corfu, Greece. *Invited talk for the Conference Kerkyra 2042*. Oct. 2022.

- [Pitching Session for Project TeleICCE]. 19 October 2022, Bari, Italy. *Invited talk hosted by the International Business Week, Towards the Greece-Italy 2021-2027 Programming.* Oct. 2022.
- [Modeling and Scalability: Selected Networking Topics]. 15 December 2021, Darmstadt University, Germany. *Invited talk hosted by the team of Prof. Ralf Steiner.* Dec. 2021.
- [Facility Location in Modern Networking Environments: Theory and Applications]. 8 March 2018, Sabanci University, Istanbul. *Invited talk hosted by Prof. Ozgur Gurbuz.* Mar. 2018.
- [Virtual Worlds, Cultural Content and Infrastructures]. 1-2 July 2016, Syros, Greece. *Invited talk hosted by the General Secretariat of Digital Strategy.* July 2016.
- [The S.M.ART.BUIL.T. Wireless Network: Going Through a Novel Architecture]. 1-2 July 2013, Corfu, Greece. *Invited talk hosted by the 2nd International Workshop on Structural Monitoring.* July 2013.
- [Advanced Structural Monitoring through Wireless Sensor Technologies]. 30 November 2012, Bari, Italy. *Invited talk hosted by the International Workshop on Structural Monitoring.* Nov. 2012.
- [Green Ethos in ICT]. 17 May 2010, Athens, Greece. *Invited talk hosted by the General Secretaries of Green ICT.* May 2010.
- [Green ICT]. 14 December 2008, Athens, Greece. *Invited talk hosted by the Technical Chamber of Greece.* Dec. 2008.

4.8 Reviews

He has reviewed a large number of research articles, the most important of which concern IEEE Infocom, IEEE Journal on Selected Areas in Communications, IEEE Transactions on Parallel and Distributed Systems, IEEE Transactions on Wireless Communications, IEEE Transactions on Vehicular Technology, IEEE Communications Magazine, IEEE Sensors Journal, IEEE Communications Letters, Computer Network (Elsevier), Ad Hoc Networks (Elsevier), Computer Communications (Elsevier), Pervasive and Mobile Computing (Elsevier) and many others (e.g., WoWMoM, NETWORKING, AOC, MedHocNet, IPDPS, WONS, WiOpt, QoFIS, ICT, IST M&CS, PWC, ICC, ICICTE, AICCSA, AINA, GCWC, BalkanCom, IISA, SEEDA).

4.9 Conference Organization (9)

Has organized the following 9 conferences with the following roles:

- BalkanCom 2021. [4th International Balkan Conference on Communications and Networking, Podgorica, Montenegro, 6-8 June 2018]. <http://www.balkancom.info/2021/>. *Role: TPC co-Chair.* Sept. 2021.
- BalkanCom 2018. [2nd International Balkan Conference on Communications and Networking, Podgorica, Montenegro, 6-8 June 2018]. <http://www.balkancom.info/2018/>. *Role: Publicity co-Chair.* June 2018.
- JCKBSE 2018. [12th Joint Conference on Knowledge-Based Software Engineering, Corfu, Greece, 27-30 August 2018]. <http://jckbse2018.unipi.gr>. *Role: Program co-Chair.* Aug. 2018.
- Algocloud 2016. [2nd International Workshop on Algorithmic Aspects of Cloud Computing, Aarhus, Denmark, 22 August 2016]. <http://conferences.au.dk/algo16/algocloud>. *Role: Workshop Program co-Chair.* Aug. 2016.
- IISA 2015. [6th Int. Conference on Information, Intelligence, Systems and Applications, Corfu, Greece, 6-8 July 2015]. <http://iisa2015.unipi.gr>. *Role: Special Session CNEA co-Chair.* July 2015.
- ISCC 2011. [IEEE Symposium on Computers and Communications, Corfu, Greece, 28 June - 1 July 2011]. <http://www.ieee-iscc.org/2011>. *Role: Local Arrangements co-Chair.* June 2011.

- AOC 2010. [IEEE WoWMoM Workshop on Autonomic and Opportunistic Communications, Montreal, Canada, 14 June 2010]. <http://cnd.iit.cnr.it/aoc2010/index.html>. *Role: Workshop co-Chair*. June 2010.
- AOC 2009. [IEEE WoWMoM Workshop on Autonomic and Opportunistic Communications, Kos, Greece, 15 June 2009]. <http://cnd.iit.cnr.it/aoc2009/index.html>. *Role: Workshop co-Chair*. June 2009.
- MedHocNet 2007. [Mediterranean Ad Hoc Networking Workshop, Corfu, Greece, 12-15 June 2007]. <http://di.ionio.gr/medhocnet07/>. *Role: Local Arrangements co-Chair*. June 2007.

5 Research and Development Programmes

Any involvement with research and development programs is about both the participation in the project team and the preparation of funding proposals. Moreover, participation in committees that plan future funding is also important.

5.1 Participation in Funded Research and Development Projects

He has participated in the research and development programs mentioned below, from research and development engineer to scientific director. In the context of these, several technical reports were prepared to support the requirements of the works (requirements, specifications, design documents) and scientific works (publications). In addition, several systems were developed (either in the form of a prototype system or in the form of source code) to demonstrate the results of the respective research projects. In most cases, Prof. K. Oikonomou was the scientific director for these deliverables and the annual evaluations (project reviews) of the managing authorities.

5.1.1 Main Funded Projects (9)

Regarding the main 9 research and development projects in which he participates/has participated, he has dealt with the issue of the quality of services in wireless local area networks,²⁰⁸ and the issue of supporting the dual operation of a wireless local area network.²⁰⁹ He then addressed the issue of creating a new network protocol stack architecture to create a new standalone autonomous example.²¹⁰ He was also involved in a project to upgrade digital Ionian University services²¹¹ as well as trying to solve synchronization issues in wireless network environments for historic buildings.²¹²

An important part of his development effort includes the work of the virtual worlds for which it was required to model about 160 buildings in the Ionian Islands.²¹³ This was followed by the work of the virtual representation of Corfu and its culture.²¹⁴ The issue of synchronization in sensor networks returns now from the point of view of crop support.²¹⁵ Education issues through

²⁰⁸HARMONICS. [(5th Framework) IST-1999-11719]. *Role: Workpackage co-ordinator on behalf of Intracom S.A.*. 2000-2003.

²⁰⁹BROADWAY. [(6th Framework) IST-2001-32686]. *Role: Workpackage co-ordinator on behalf of Intracom S.A.*. 2002-2005.

²¹⁰Autonomic Network Architecture (ANA), see n. 8, p. 3.

²¹¹Ionian University Digital Planning Services. [ESPA 2007-2013]. *Role: Co-ordinator on behalf of the Ionian University*. 2010-2015.

²¹²S.M.ART.BUIL.T., see n. 125, p. 16.

²¹³Ionian Islands Virtual World, see n. 112, p. 15.

²¹⁴corfu.

²¹⁵OLI-Net, see n. 128, p. 16.

video conferencing platforms have also been studied and various actions have been implemented in the framework of the cross-border project.²¹⁶

The list of these 9 projects is summarized as follows:

Autonomic Network Architecture (ANA). [(FET) IST-27489]. *Role: Post-doc researcher on behalf of the National & Kapodistrian University of Athens.* 2005-2010.

BROADWAY. [(6th Framework) IST-2001-32686]. *Role: Workpackage co-ordinator on behalf of Intracom S.A.* 2002-2005.

HARMONICS. [(5th Framework) IST-1999-11719]. *Role: Workpackage co-ordinator on behalf of Intracom S.A.* 2000-2003.

Ionian Islands Virtual World. [ESPA 2007-2013]. *Role: Co-ordinator on behalf of the Ionian University.* 2012-2015.

OLI-Net. [ESPA 2014-2020]. *Role: Co-ordinator on behalf of the Ionian University.* 2017-2020.

S.M.ART.BUIL.T. [Interreg Greece-Italy]. *Role: Technical co-ordinator on behalf of the Ionian University.* 2012-2015.

Ionian University Digital Planning Services. [ESPA 2007-2013]. *Role: Co-ordinator on behalf of the Ionian University.* 2010-2015.

TELEICCE. [Interreg Greece-Italy]. *Role: Co-ordinator on behalf of the Ionian University.* 2018-2020.

v-Corfu. [ESPA 2014-2020]. *Role: Team member (former Co-ordinator) on behalf of the Ionian University.* 2019-2022.

During his professional involvement in Intracom SA, he was involved with various roles in several research and development projects, such as CASPIAN (2/2000 - 2/2001, researcher responsible for implementation of a virtual device driver for the Linux Kernel that allows the direct loading of network protocols in the kernel of the system), BROADBAND IP (2/2000 - 2/2002, project coordinator for the creation of a system that simulates the existence of a satellite network and the implementation of the necessary modifications for the efficient operation of TCP in satellite networks), ADAMAS (4/2002 - 4/2003, researcher responsible for the interconnection of protocols with the operating system kernel of the original platform), ROMANTIK (2/2004 - 1/2005, project coordinator the expansion of the coverage area of a network with multi-wave techniques), E-NEXT (1/2004 - 1/2005, a researcher in the context of the effort to build a scientific network under the auspices of the 6th Framework.

5.1.2 Publications per Funded Project

The following is the list of publications that are directly related to any of the previously mentioned projects. This is important to highlight research results especially since funded projects may not always have a research orientation.

v-Corfu²¹⁷ (19)

Vasileios Dragonas, Dimitrios Kallergis, Georgios Tsoumanis, and Konstantinos Oikonomou. “On Utilizing Unused Slots In Topology-Transparent TDMA MAC Policies for Ad Hoc Networks”. In: *2022 Global Information Infrastructure and Networking Symposium (GIIS) (GIIS'22)*. Argostoli, Greece, Sept. 2022.

²¹⁶TELEICCE. [Interreg Greece-Italy]. *Role: Co-ordinator on behalf of the Ionian University.* 2018-2020.

²¹⁷v-Corfu. [ESPA 2014-2020]. *Role: Team member (former Co-ordinator) on behalf of the Ionian University.* 2019-2022.

- Vasileios Dragonas, Georgios Tsoumanis, and Konstantinos Oikonomou. “A Probabilistic Refined Policy For Topology Independent Medium Access Control In Ad Hoc Network Environments”. In: *ITU Journal on Future and Evolving Technologies - Emerging trends and applications in future communication networks* 3.2 (Sept. 2022), pp. 483–497.
- Konstantinos Oikonomou. “A Spectrum Analysis Approach for the Median Problem in Modern Network Environments”. In: *2022 IEEE Symposium on Computers and Communications (ISCC)* (Rhodes, Greece). June 2022.
- Asterios Papamichail, Athanasios Tsipis, Georgios Tsoumanis, and Konstantinos Oikonomou. “Study of a Proposed Spectral-based Approach for Facility Location in Tree Topologies”. In: *2022 Global Information Infrastructure and Networking Symposium (GIIS) (GIIS’22)*. Argostoli, Greece, Sept. 2022.
- Athanasios Tsipis, Sofia Fanarioti, Vasileios Komianos, Spyros Sioutas, and Konstantinos Oikonomou. “A Study on Robustness for the Single Server Location in Distributed Interactive Applications”. In: *2022 Global Information Infrastructure and Networking Symposium (GIIS) (GIIS’22)*. Argostoli, Greece, Sept. 2022.
- Athanasios Tsipis, Vasileios Komianos, and Konstantinos Oikonomou. “Fairness-Oriented Edge Allocation for Interactive Group Gaming in Edge Computing”. In: *2022 13th International Conference on Information, Intelligence, Systems and Applications (IISA)* (Corfu, Greece). 2022.
- Athanasios Tsipis, Vasileios Komianos, Konstantinos Oikonomou, and Ioannis Stavrakakis. “Towards Fairness and QoE Based Edge Allocation for Multiplayer Virtual Reality Applications in Edge Computing”. In: *ITU Journal on Future and Evolving Technologies - Digital Continuum and Next Generation Networks* (2022).
- Athanasios Tsipis and Konstantinos Oikonomou. “Joint optimization of social interactivity and server provisioning for interactive games in edge computing”. In: *Computer Networks* 212 (2022), p. 109028.
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5.2 Project Proposal Preparation

In addition to participating in various projects, Prof. K. Oikonomou has written and submitted various proposals for funding which have either been successful or not. In particular, it has submitted proposals for funding at the European level (STREP, FET), having set up the research team (consortium), and coordinated them in drafting the proposal. He has also submitted proposals for cross-border cooperation in either Greece-Italy and Greece-Albania thematic cooperation, in Greek Ministry announcements (e.g., Invitation 184, Research-Innovate), in Digital Convergence, ELIDEK, GSRT as well as in announcements of the Ionian Islands Region (ESPA 2007-2013 and ESPA 2014-2020).

6 Teaching

His teaching work started in the spring semester of 2006. It is uninterrupted in courses related to Computer Networks in undergraduate and postgraduate studies while he has supervised respective 84 undergraduate and postgraduate theses.

6.1 Courses

In the Department of Informatics of the Ionian University, he teaches courses on telecommunications and networks in the undergraduate course (Information Theory, Networks I, Networks II, Distributed Network-Centered Systems) and in the postgraduate course (Networks, Networks, Communication Networks, and Mobile Communications, Advanced Data Network Themes, Network Performance Modeling and Analysis). He also undertook courses related to operating systems and virtual worlds in the context of serving the needs of the Department while also serving the needs of other Departments in Informatics (e.g., the respective Informatics courses of the Department of Foreign Languages, Translation and Interpretation).

6.2 Undergraduate and Postgraduate Supervision (84)

He has supervised a total of 84 theses, of which 49 in the postgraduate and 35 in the undergraduate course.

6.3 Summer Schools (4)

He has participated/organized 4 summer schools:

[Ionian Islands Virtual World: Monuments and Locations]. 7-22 August 2017, Corfu, Greece. *Invited talk in the Greek Language and Culture Summer School organized by the Department of History, Ionian University.* Aug. 2017.

[Principles of Informatics - Applications in Robotics]. 19-23 June 2017, Corfu, Greece. *Organizer of Summer School Principles of Informatics - Applications in Robotics organized by the Department of Informatics, Ionian University.* June 2017.

[Virtual Worlds and Promotion of Cultural Heritage]. 6-12 July 2017, Corfu, Greece. *Invited talk in the Summer School Digital Technologies & Innovation in Tourism Entrepreneurship organized by the Department of Informatics, Ionian University.* July 2017.

[Ionian Islands Virtual World: Monuments and Locations]. 1-31 August 2018, Corfu, Greece.
Invited talk in the Greek Language and Culture Summer School organized by the Department of History, Ionian University. Aug. 2018.

7 Administrative Work

The administrative work he has undertaken during his tenure at the Department of Informatics of the Ionian University since his first appointment as a faculty member in 2007, is pervasive. Throughout this period, there is intense activity and participation in various committees such as the undergraduate program committee, institute committees (e.g., Informatics and Communications Committee), competition committees, drafting regulations in the Department (postgraduate program, dissertations, event for doctoral candidates, etc.), organization of procedures, etc. Furthermore, from May 2018 until May 2020, he was the Director (one term) of the Postgraduate Studies Program entitled “Research Directions in Informatics” of the Department of Informatics. He remains a member of the boarding committee of the specific postgraduate.

Prof. K. Oikonomou, since becoming Associate Professor in 2017 undertook further and more extensive official duties. In particular, from May 2017 until October of the same year, he was President of the Department of Informatics, while from December 2017 to August 2021 he was Dean of the School of Information Science and Informatics of the Ionian University. The specific position in which he serves has many administrative duties.

8 List of Publications (138)

Prof. K. Oikonomou’s scientific publications can be categorized into those published in crisis journals and conferences and other publications. He was either invited to submit a paper or took place as part of a project or edited volumes.

8.1 Referred Publications(129)

He has authored 129 referred publications, of which 46 in journals and 83 conferences. His work has received until now 1127 references with h-index 19, g-index 28 and i10-index 27.²²⁴

8.1.1 Journals (46)

Konstantinos Bezas, Georgios Tsoumanis, Constantinos T Angelis, and Konstantinos Oikonomou. “Coverage Path Planning and Point of Interest Detection Using Autonomous Drone Swarms”. In: *Sensors* (2022).

Vasileios Dragonas, Georgios Tsoumanis, and Konstantinos Oikonomou. “A Probabilistic Refined Policy For Topology Independent Medium Access Control In Ad Hoc Network Environments”. In: *ITU Journal on Future and Evolving Technologies - Emerging trends and applications in future communication networks* 3.2 (Sept. 2022), pp. 483–497.

Konstantinos Oikonomou, George Koufoudakis, Sonia Aïssa, and Ioannis Stavarakakis. “Probabilistic Flooding Performance Analysis Exploiting Graph Spectra Properties”. In: *IEEE/ACM Transactions on Networking* (2022), pp. 1–14.

²²⁴Source: Google Scholar using the Publish or Perish software.

- Athanasios Tsipis, Vasileios Komianos, Konstantinos Oikonomou, and Ioannis Stavrakakis. “Towards Fairness and QoE Based Edge Allocation for Multiplayer Virtual Reality Applications in Edge Computing”. In: *ITU Journal on Future and Evolving Technologies - Digital Continuum and Next Generation Networks* (2022).
- Athanasios Tsipis and Konstantinos Oikonomou. “Joint optimization of social interactivity and server provisioning for interactive games in edge computing”. In: *Computer Networks* 212 (2022), p. 109028.
- “ARPA: An autonomous renderer placement algorithm in distributed multimedia fog networks with delay guarantees”. In: *ITU Journal on Future and Evolving Technologies (ITU J-FET)* 2.2 (2021).
- Georgios Tsoumanis, Konstantinos Oikonomou, Sonia Aïssa, and Ioannis Stavrakakis. “Energy and Distance Optimization in Rechargeable Wireless Sensor Networks”. In: *IEEE Transactions on Green Communications and Networking* 5.1 (Mar. 2021), pp. 378–391.
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- Athanasios Tsipis, Asterios Papamichail, George Koufoudakis, Georgios Tsoumanis, Spyros E. Polykalas, and Konstantinos Oikonomou. “Latency-Adjustable Cloud/Fog Computing Architecture for Time-Sensitive Environmental Monitoring in Olive Groves”. In: *AgriEngineering* 2.1 (2020), pp. 175–205.
- Georgios Tsoumanis, Asterios Papamichail, Vasileios Dragonas, George Koufoudakis, Konstantinos T Angelis, and Konstantinos Oikonomou. “Implementation of a Topology Independent MAC (TiMAC) Policy on a Low-Cost IoT System”. In: *Future Internet* 12.5 (2020), p. 86.
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8.2 Various Publications and Editions (9)

Prof. K. Oikonomou has published 9 works that have not gone through a review process. These are mostly research works that he was invited to submit or about a research project, the editor of a volume, or a chapter in a book.

8.2.1 Journals

- George Koufoudakis, Nikos Skiadopoulos, Emmanouel Magkos, and Konstantinos Oikonomou. “Synchronization Issues in an Innovative Wireless Sensor Network Architecture Monitoring Ambient Vibrations in Historical Buildings”. In: *Key Engineering Materials* 628 (2014).
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8.2.2 Conferences

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8.2.3 Book Editing

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Timos Sellis and Konstantinos Oikonomou. *Algorithmic Aspects of Cloud Computing*. Springer, 2017.

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Ioannis Angelis et al. “Smart Agriculture: A Low-Cost Wireless Sensor Network Approach”. In: *Information and Communication Technologies for Agriculture—Theme I: Sensors*. Ed. by Dionysis D. Bochtis, Maria Lampridi, George P. Petropoulos, Yiannis Ampatzidis, and Panos Pardalos. Cham: Springer International Publishing, 2022, pp. 139–172.

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