# On the Statistical Analysis of Wireless Sensor vs. Wired Data Network Traffics

Z. Gal*, Gy. Terdik**
*Service Center for Informatics, University of Debrecen, Debrecen, Hungary
**Faculty of Informatics, University of Debrecen, Debrecen, Hungary

***Abstract*—Not only the infrastructure of Wireless Sensor Network (WSNs) and classical wired IP data networks are very different but the statistical characteristics of data flows transferred on these environments have technology specific features, too. Based on the dynamic evolution in the last years WSNs became important elements of the small physical sized network architectures and are included as basic components in the Internet of Things (IoT) new concept. The challenge to transmit packets on optimum wireless path with minimum energy consumption affects all layer (physical, data link, network, transport, application) services of the WSN protocol stack. Wireless IP data technologies like GSM/UMTS/WiFi/WiMAX are utilized with success in WAN/MAN networks in contrast with WSN, which is usable only for small distances and reduced transfer capacity of bytes. Because of the energy consumption minimization the channel access mechanism should be simple as much as possible. Classical IP traffics in LAN/WAN environment do not confront with consequences of the energy constraints. The MAC algorithms are much more sophisticated than for WSNs. The difference in the layer functions implies difference in the traffic characteristics of this two network types. In this paper WSN and IP WAN/MAN data flows are analyzed as time series. Thesensor data flows were collected with TinyDB tools at the Intel Berkeley Research lab in 2004. The high speed IP data flows are available from public database of TIER links[1]. These significantly different types of data flowsare investigated based on Lévy flights modeling. Long range dependence, self-similarity aspects of the inter-arrival time and the epoch ID time series are studied with sophisticated statistical analysis methods.**

[1]CAIDA's OC48 Traces is provided by the National Science Foundation, the US Department of Homeland Security, DARPA, Digital Envoy, and CAIDA Members.

## REFERENCES

[1] I.F. Akyildiz, W. Su, Y. Sankarasubramaniam, E. Cayirci, "Wireless Sensor Networks: a Survey", *Computer Networks 38 (2002), Elsevier*, pp. 293-422.

[2] John A. Stankovic, "Wireless Sensor Networks", *Communications of the ACM – Wireless sensor networks (2004)*, Vol. 47 Issue 6.

[3] Jennifer Yick, Biswanath Mukherjee, DipakGhosal, "Wireless sensor network survey", *Computer Networks 52 (2008), Elsevier*, pp. 2292-2330.

[4] Feng Zhao, Leonidas J. Guibas, "Wireless Sensor Networks: An Information Processing Approach", *Elsevier (2004).*

[5] Sam Madden, Joe Hellerstein, Wei Hong, "TinyDB: In-Network Query Processing in TinyOS", *Technical Report TinyOS Document*, Version 0.4, September 2003.

[6] Ameer Ahmed Abbasi, Mohamed Younis, "A Survey on Clustering Algorithms for Wireless Sensor Networks", *Computer Communications 20 (2007), Elsevier*, pp. 2826-2841.

[7] Jamal N. Al-Karaki, Ahmed E. Kamal, "Routing techniques in Wireless Sensor Networks: a Survey", *IEEE Wireless Communications, 11(6):6-28*, 2004.

[8] WaltenegusDargie, Christian Poellabauer, "Fundamentals of Wireless Sensor Networks", *Wiley Series on Wireless Communications and Mobile Computing*, 2010.

[9] J.N. Al-Karaki and A.E. Kamal, "Routing Techniques in Wireless Sensor Networks: a Survey," *IEEE Wireless Communications11 (2004) (6)*, pp. 6–28

[10] Intel Berkeley lab. http://db.csail.mit.edu/labdata/labdata.html.

[11] Ping Ji, MarcinSzczodrak, "A Multivariate Model for Data Cleansing in Sensor Networks", *The Second Annual Conference of the International Technology Alliance (2008).*

[12] Yann-Ael Le Borgne, Silvia Santini, GianlucaBontempi,"Adaptive Model Selection for Time Series Prediction in Wireless Sensor Networks" *Signal Processing, Volume 87 Issue 12*, December, 2007.

[13] Ameer Ahmed Abbasi, Mohamed Younis, "A survey on clustering algorithms for wireless sensor networks" *Computer Communications, Volume 30 Issue 14-15*, October, 2007, pp. 2826-2841.

[14] BaljeetMalhotra, IonisNikolaidis, Mario A. Nascimento, "Aggregation Convergecast Scheduling in Wireless Sensor Networks", *Kluwer Academic Publishers, Wireless Networks, Volume 17 Issue 2*, February 2011.

[15] Yong Hyun Cho, Jihoon Son, Yon Dohn Chung, "POT: An Efficient Top-k Monitoring Method for Spatially Correlated Sensor Readings", *ACM Proceedings of the 5th workshop on Data management for sensor networks*, 2008.

[16] Chong Liu, Kui Wu, Jian Pei, "An Energy Efficient Data Collection Framework for Wireless Sensor Networks by Exploiting Spatiotemporal Correlation", *IEEE Transactions on Parallel and Distributed Systems, Volume 18 Issue 7*, July 2007, pp. 1010-1023.

[17] David Chu, AmolDeshpande, Joseph M. Hellerstein, Wei Hong, "Approximate Data Collection in Sensor Networks using Probabilistic Models", *IEEE Computer Society ICDE'06 Proceedings of the 22nd International Conference on Data Engineering*, 2006.

[18] Hejun Wu, QiongLuo, Jianjun Li, AlexandrosLabrinidis, "Quality aware query scheduling in wireless sensor networks", *ACM DMSN'09 Proceedings of the Sixth International Workshop on Data Management for Sensor Networks*, 2009.

[19] David Yates, Erich Nahum, Jim Kurose, "Data Quality and Query Cost in Wireless Sensor Networks", *PERCOMW '07 Proceedings of the Fifth IEEE International Conference on Pervasive Computing and Communications Workshops*, 2007.

[20] Su Ping, "Delay Measurement Time Synchronization for Wireless Sensor Networks", *ACM Transactions on Sensor Networks (TOSN), Volume 3 Issue 2*, June 2007.

[21] Carlos Guestrin, Peter Bodik, RomainThibaux, Mark Paskin, Samuel Madden, "Distributed Regression: an Efficient Framework for Modeling Sensor Network Data", *IPSN'04 - Information Processing in Sensor Networks*, 2004.

[22] "TinyDB: A Declarative Database for Sensor Networks," http://telegraph.cs.berkeley.edu/tinydb/documentation.htm

[23] Jan F. Akyildiz, Mehmet Can Vuran, "Wireless Sensor Networks," *John Wiley& Sons Ltd. (2010),* ISBN: 978-0-470-03601-3

[24] Samuel R. Madden, Michael J. Franklin, Joseph M. Hellerstein, Wei Hong: TinyDB: An AcquisitionalQuery Processing System for Sensor Networks, *ACM Trans. Database Syst., Vol. 30, No. 1. (March 2005)*, pp. 122-173.

[25] Gy. Terdik, T. Gyires: Internet Traffic Modeling with Lévy Flights, *IEEE/ACM Transactions on Networking, Vol. 17, No. 1*, pp. 120-129, February 2009.

[26] Z. Gal: VoIP LAN/MAN Traffic Analysis for NGN QoS Management, *Infocommunications Journal, Volume LXIV*, pp. 22-29, 2009.

[27] R. N. Mantegna and H. E. Stanley. Stochastic processes with ultraslow convergence to a Gaussian: The truncated Lévy Flight. Phys. Rev. Lett.73, pp.2946-2949, 1994.

[28] J. Rosinski. Tempering stable processes. Stochastic Processes and their Applications, Volume 117, Issue 6, June 2007, pp. 677-707

[29] Gy. Terdik and W. A. Woyczynski. Rosiñski measures for tempered stable and related Ornstein-Uhlenbeck processes. Probability and Mathematical Statistics (PMS), Urbanik volume: 26, 21—3243, 2006.Rosinski. Tempering stable processes.
Stochastic Processes and their Applications, Volume 117, Issue 6, June 2007, pp. 677-707

[30] Gy. Terdik, T. Gyires, "Does the Internet Still Demonstrate Fractal Nature?," International Conference on Networking, pp. 30-34, 2009 Eighth International Conference on Networks, 2009, Gosier, Guadeloupe, France, March 01-March 06, ISBN: 978-0-7695-3552-4