

Device-centric sensing: An alternative to data-centric approaches

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Abstract

© 2007-2012 IEEE. When pieces of information originate from the physical world through the sensing infrastructure, there is a pressing need to cope with the overhead and inherent limitations lying in merely shifting huge amounts of aggregated data across the net. In this scenario, a key point is the minimization of wasted bandwidth to accommodate for ever-growing demands of sensing data. For effective treatment of sensing data, BigData principles and approaches should be adopted, particularly the one by which computing has to be brought as near as possible to data. In this paper, we propose a new approach to deal with sensing data inspired by this principle, injecting intelligence on the device instead of just using it as source of data, thus reversing the trend from the current data-centric paradigm toward a device-centric one. This way, we shift the focus from the application level onto the infrastructure one, adopting a Cloud-oriented approach to abstract and virtualize sensor-hosting boards ready to be reconfigured with custom logic, such as MapReduce, by providing resources on demand, as a service. Theoretical, design, and technical aspects have been addressed in this paper through the evaluation of a device-centric sensing infrastructure-as-a-service (IaaS) stack implementation. In particular, a prototype for mobiles is described, getting into platform-dependent details where needed. The facilities so far implemented under the Android platform have been put under preliminary testing through a mobile application.

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Keywords

BigData, Cloud, infrastructure as a service (IaaS), mobiles, sensing abstraction and virtualization, sensors and actuators

References

- [1] The Zettabyte Era: Trends and Analysis-White Paper, Cisco Visual Networking Index (VNI), CISCO Systems, San Jose, CA, USA, Jun. 2014. [Online]. Available: <http://www.cisco.com/c/en/us/solutions/collateral/service-provider/visual-networking-index-vni/VNI-Hyperconnectivity-WP.pdf>
- [2] Top 10 Strategic Technology Trends for 2013, 2013. [Online]. Available: <http://www.gartner.com/technology/research/top-10-Technology-Trends/>
- [3] P. Banerjee, et al., "Everything as a service: Powering the new information economy," *Computer*, vol. 44, no. 3, pp. 36-43, Mar. 2011.
- [4] C. Perera, A. Zaslavsky, P. Christen, and D. Georgakopoulos, "Sensing as a service model for smart cities supported by Internet of Things," *Trans. Emerging Telecommun. Technol*, vol. 25, no. 1, pp. 81-93, Jan. 2014. [Online]. Available: <http://dx.doi.org/10.1002/ett.2704>

- [5] S. Distefano, G. Merlino, and A. Puliafito, "Sensing and actuation as a service: A new development for clouds, " in Proc. IEEE 11th Int. Symp. NCA, Cambridge, MA, USA, 2012, pp. 272-275. [Online]. Available: <http://dx.doi.org/10.1109/NCA.2012.38>
- [6] L. Cremer, S. Distefano, G. Merlino, and A. Puliafito, "Abstraction of onboard resources in mobiles: SaaS4mobile, a first step towards a sensing cloud, " in Proc. 10th IEEE Int. Conf. HPCC/EUC, Zhangjiajie, China, Nov. 13-15, 2013, pp. 674-681. [Online]. Available: <http://dx.doi.org/10.1109/HPCC.and.EUC.2013.100>
- [7] A. Shokrollahi, "Raptor codes, " IEEE Trans. Inf. Theory, vol. 52, no. 6, pp. 2551-2567, Jun. 2006.
- [8] M. Wang, and B. Li, "R2: Random push with random network coding in live peer-To-peer streaming, " IEEE J. Sel. Areas Commun, vol. 25, no. 9, pp. 1655-1666, Dec. 2007. [Online]. Available: <http://dx.doi.org/10.1109/JSAAC.2007.071205>
- [9] X. Sheng, J. Tang, X. Xiao, and G. Xue, "Sensing as a service: Challenges, solutions and future directions, " IEEE Sensors J, vol. 13, no. 10, pp. 3733-3741, Oct. 2013.
- [10] R. Mizouni, and M. El Barachi, "Mobile phone sensing as a service: Business model and use cases, " in Proc. 7th Int. Conf. NGMAST, 2013, pp. 116-121.
- [11] Software-Defined Networking: The New Norm for Networks, White Paper, Open Networking Foundation, Palo Alto, CA, USA, Apr. 13, 2012.
- [12] IOT- A Project Consortium, "Final architectural reference model for the IoT, " VDI/VDE Innovation + Technik GmbH, Berlin, Germany, Tech. Rep., 2013. [Online]. Available: <http://www.iot-A.eu/public/publicdocuments/d1.5/view>
- [13] OGC(R) Sensor Planning Service Implementation Standard, 2nd ed., Open Geospatial Consortium (OGC), Wayland, MA, USA, 2011.
- [14] Apache Storm, Apache Foundation, Forest Hill, MD, USA, 2015. (Accessed January 6, 2015). [Online]. Available: <https://storm.apache.org/documentation/Tutorial.html>
- [15] Y. Zhou, X. Zhang, X. Jiang, and V. W. Freeh, "Taming informationstealing smartphone applications (on android), " in Trust and Trustworthy Computing. Berlin, Germany: Springer-Verlag, 2011, pp. 93-107.
- [16] E. Fernandes, A. Crowell, A. Aluri, and A. Prakash, "Anception: Application virtualization for android, " CoRR, vol. abs/1401.6726, 2014.
- [17] M. Gordon, L. Zhang, and B. Tiwana, PowerTutor A Power Monitor for Android-Based Mobile Platforms, 2011. [Online]. Available: <http://ziyang.eecs.umich.edu/projects/powertutor/>
- [18] Y. Wang, S. Jain, M. Martonosi, and K. Fall, "Erasure-coding based routing for opportunistic networks, " in Proc. ACM SIGCOMM WDTN, New York, NY, USA, 2005, pp. 229-236. [Online]. Available: <http://doi.acm.org/10.1145/1080139.1080140>
- [19] T. Ho, et al., "A random linear network coding approach to multicast, " IEEE Trans. Inf. Theory, vol. 52, no. 10, pp. 4413-4430, Oct. 2006.
- [20] R. Ahlswede, N. Cai, S.-Y. R. Li, and R. W. Yeung, "Network information flow, " IEEE Trans. Inf. Theory, vol. 46, no. 4, pp. 1204-1216, Jul. 2000.
- [21] T. Clohessy, T. Acton, and L. Morgan, "Smart city as a service (SCAAS)- A future roadmap for e-government smart city cloud computing initiatives, " in Proc. 1st Int. Workshop Smart City Clouds, Technol., Syst. Appl., London, U. K., Dec. 2014, pp. 836-842.
- [22] S. Alam, M. Chowdhury, and J. Noll, "SENAAS: An event-driven sensor virtualization approach for Internet of Things cloud, " in Proc. IEEE Int. Conf. NESEA, Nov. 2010, pp. 1-6.
- [23] BETaaS Consortium, BETaaS Building the Environment for the Things as a Service, 2012. [Online]. Available: <http://www.betaas.eu/>
- [24] M. Yuriyama, and T. Kushida, "Sensor-cloud infrastructure-Physical sensor management with virtualized sensors on cloud computing, " in Proc. 13th Int. Conf. NBIS, Sep. 2010, pp. 1-8.
- [25] M. Avvenuti, P. Corsini, P. Masci, and A. Vecchio, "An application adaptation layer for wireless sensor networks, " Pervasive Mobile Comput, vol. 3, no. 4, pp. 413-438, Aug. 2007. [Online]. Available: <http://dx.doi.org/10.1016/j.pmcj.2007.04.001>
- [26] M. Iqbal, D. Yang, T. Obaid, T. J. Ng, and H. B. Lim, "Demo abstract: A service-oriented application programming interface for sensor network virtualization, " in Proc. 10th Int. Conf. IPSN, Apr. 2011, pp. 143-144.
- [27] J. Jamsa, et al., "A mobile data collection framework for the sensor web, " in Proc. UPINLBS, 2010, pp. 1-8.
- [28] G. Gil, A. B. de Jesus, and J. Molina Lopez, "inContexto: A fusion architecture to obtain mobile context, " in Proc. 14th Int. Conf. Inf. FUSION, 2011, pp. 1-8.