Low-Power System Design

Introduction to the Reading/Writing Seminar

227-0781-00L

Fall Semester 2019

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Reading and Writing Seminar

- Reading assignment of 1 paper per week – **until FRIDAY**
  - 2-3 students prepare a written summary (max. 200-300 words)
    - Write-up should contain the (i) essential points of the paper, (ii) it's main contribution and (iii) your assessment
    - Research of related work: recent papers, different approaches, historical background…
  - Summary is shared with all via discussion forum (matrix chatroom)

- Discussion/questions/comments – **FRIDAY to WEDNESDAY**
  - EVERYBODY comments on review summary and paper
    - Your own opinion
    - Corrections/additions to the reviewers voice
    - Additional questions
  - Joint search for related work, interesting ecosystem etc.

- Joint discussion of papers in class – **WEDNESDAY in class**
  - Short presentation of paper and summary in class to kick off discussion
  - Presentation using max. 3-4 slides (not a full paper presentation)

- Reading/writing and your contributing to the discussions is part of the grade (30%)

- Assignment via signup sheet with
  - 1x summary write-up/paper presentation
  - 4x review/commenting per student

Why Reading and Writing?

- The purpose of the reading and writing seminar is to introduce the fundamental research in low-power systems design in order to enable you to work on a research project of publishable quality.
- This requires reading deeply on a wide range of topics.
- Individual research into further literature might be required to better understand a publication.
- The main goal of the paper summaries is to encourage you to read the papers thoroughly before the class.
- You will be required to submit a short summary of the paper before the class.
- Active discussion will (hopefully) give you a non-trivial understanding of the material. It will enhance your ability to think critical. The only way this approach can work is if you read the papers carefully.
- Class time will not be used to rehash the material in the papers. Instead, it will be used to highlight the important points and discuss some of the more interesting features.

How to Read

- Read each paper approximately 3 times:
  - First a fast pass omitting the hard parts, e.g. formal proofs
  - A second time more carefully
  - On the third part concentrate on the hard parts
- Organize your reading
  - Take notes
  - Create a repository/bibliography
- Discuss your reading with others

- Resources
  - How to Read a Paper by S. Keshav
  - How to Read a Research Paper by Michael Mitzenmacher
  - Writing Reviews for Systems Conferences by Timothy Roscoe
  - How to Read an Engineering Research Paper by William Griswold
  - How to Read a Research Paper by Spencer Rugaber

How to Write a Summary

- Describe the essence of the work selected in your own words
  - essential points of the paper
  - it's main contribution
  - your assessment
- Your summary should aim at answering these questions:
  - What problem does the paper solve and why is it important?
  - What is the hypothesis of this work?
  - What solution does the paper propose and what is the key insight?
  - Does the idea work, and if so, how well?
  - Based on the assumptions the paper makes, is the technical approach advocated suitable? Do the author's claims match?
  - Is there a drawback or limitation of the system and how you might improve it?
- For some papers, one or more of the questions might not be directly applicable. Use your own judgment.
- Try to find at least one other related publication within the context of the current paper.

In Other Words (A Bit Longer)

- Describe the essence of the work selected in your own words.
- Answer the following questions (aka. *Whose mind is to be changed about what?)*
  - What is the problem?
  - Why is it important?
  - Why is it complex?
  - What is the new solution proposed?
  - What are the subproblems (if there are any)?
- Classify the work: seminal discovery, incremental/variation, survey, experience report, …
- Describe how the analysis is performed and what prerequisites are necessary for this (data, setup, compute power, assumptions, …). Is it possible to recreate this work based on the information given in the paper?
- If you have doubts on any part of the analysis give reasons why you think so and determine what lead the authors to think otherwise.
- Determine a single aspect in the original paper that you think you can improve substantially and in a defensible way. Explain how to go about this improvement. Build a model and give estimates on the improvements targeted. Real experiments to back up your claim are a plus.

Derived from Gary King, Harvard, Jan Rabaey, UC Berkeley

IMPORTANT: Putting Reading into Context

- Research for related work on the same topic/approach for
  - Gaining a deeper understanding
  - Identifying the impact of this work

- Resources
  - Libraries (online), e.g. ACM DL
  - Internet
  - Google Scholar
  - Web of Knowledge
  - Mendeley

- Top conferences
  - SenSys, IPSN, EWSN, MobiCom, MobiHoc, DATE, ESWEEK, NSDI, OSDI, SOSP …

Reading List LPSD 2019

1. Kahn, J. M., Katz, R. H., & Pister, K. S. J. (1999). **Next century challenges: mobile networking for ``Smart Dust''**. In *MobiCom 99 Proceedings of the 5th annual ACMIEEE international conference on Mobile computing and networking* (Vol. 2, pp. 271–278).
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3. Werner-Allen, G., Lorincz, K., Johnson, J., Lees, J., Welsh, M. (2006) **Fidelity and yield in a volcano monitoring sensor network**. Proceedings of the 7th Symposium on Operating systems design and implementation, pp. 381-396, 2006, USENIX Association.
4. Hill, J., Szewczyk, R., Woo, A., Hollar, S., Culler, D., & Pister, K. (2000). **System architecture directions for networked sensors**. ACM SIGOPS Operating Systems Review, 34(5), 93–104.
5. Benini, L., Bogliolo, a., & De Micheli, G. (2000). **A survey of design techniques for system-level dynamic power management.** IEEE Transactions on Very Large Scale Integration (VLSI) Systems, 8(3), 299–316.
6. Polastre, J., Hill, J., & Culler, D. (2004). **Versatile low power media access for wireless sensor networks**. In Proceedings of the 2nd international conference on Embedded networked sensor systems - SenSys '04 (p. 95). New York, New York, USA: ACM Press.
7. Tijs van Dam and Koen Langendoen. 2003. **An adaptive energy-efficient MAC protocol for wireless sensor networks**. In Proceedings of the 1st international conference on Embedded networked sensor systems (SenSys '03). ACM, New York, NY, USA, 171-180.
8. Ferrari, F., Zimmerling, M., Thiele, L., & Mottola, L. (2012). **The low-power wireless bus.** *Proceedings of the 11th International Conference on Information Processing in Sensor Networks - IPSN '12*.
9. Maroti, M., Kusy, B., Simon, G., & Ledeczi, Akos. (2004). **The flooding time synchronization protocol**. *Proc. 2nd international conference on Embedded networked sensor systems - SenSys '04* (p. 39).
10. Shnayder, V., Hempstead, M., Chen, B., Allen, G. W., & Welsh, M. (2004). **Simulating the power consumption of large-scale sensor network applications**. In *Proceedings of the 2nd international conference on Embedded networked sensor systems - SenSys '04* (p. 188). New York, New York, USA: ACM Press.
11. S. Roundy, P. K. Wright , J. Rabaey: **A study of low level vibrations as a power source for wireless sensor nodes**. *Computer Communications*, Volume 26, Issue 11, 1 July 2003, Pages 1131–1144.
12. Martin, P., Charbiwala, Z. and Srivastava, M. (2012): **DoubleDip: Leveraging thermoelectric harvesting for low power monitoring of sporadic water use**. In Proceedings of the 10th ACM Conference on Embedded Network Sensor Systems (SenSys '12). ACM, New York, NY, USA, 225-238.

An Example

- Polastre, J., Szewczyk, R., & Culler, D. (2005). **Telos: Enabling ultra-low power wireless research**. In *2005 4th International Symposium on Information Processing in Sensor Networks, IPSN 2005* (Vol. 2005, pp. 364–369).

Further Reading

- Polastre, J., Szewczyk, R., & Culler, D. (2005). **Telos: Enabling ultra-low power wireless research**. In *2005 4th International Symposium on Information Processing in Sensor Networks, IPSN 2005* (Vol. 2005, pp. 364–369).
- Malinowski, M., Moskwa, M., Feldmeier, M., Laibowitz, M., & Paradiso, J. a. (2007). **CargoNet: a low-cost micropower sensor node exploiting quasi-passive wakeup for adaptive asynchronous monitoring of exceptional events.** In Proceedings of the 5th International Conference on Embedded Networked Sensor Systems (SenSys 2007), 145.
- Dutta, P., Grimmer, M., Arora, A., Bibykt, S., & Culler, D. (2005). **Design of a wireless sensor network platform for detecting rare, random, and ephemeral events**. In 2005 4th International Symposium on Information Processing in Sensor Networks, IPSN 2005 (Vol. 2005, pp. 497–502).
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- É. Morin, M. Maman, R. Guizzetti and A. Duda, **Comparison of the Device Lifetime in Wireless Networks for the Internet of Things**, in IEEE Access, vol. 5, pp. 7097-7114, 2017. doi: 10.1109/ACCESS.2017.2688279.
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- Naveed Anwar Bhatti, Muhammad Hamad Alizai, Affan A. Syed, and Luca Mottola. 2016. **Energy Harvesting and Wireless Transfer in Sensor Network Applications: Concepts and Experiences**. *ACM Trans. Sen. Netw*. 12, 3, Article 24 (August 2016)
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- El-Hoiydi, A., & Decotignie, J.-D. (2007). **WiseMAC: an ultra low power MAC protocol for the downlink of infrastructure wireless sensor networks**. In Proceedings. ISCC 2004. Ninth International Symposium on Computers And Communications (IEEE Cat. No.04TH8769) (Vol. 1, pp. 244–251). IEEE.
- Österlind, F., Mottola, L., Voigt, T., Tsiftes, N., & Dunkels, A. (2012). **Strawman: Resolving Collisions in Bursty Low-Power Wireless Networks.** In Proceedings of the 11th international conference on Information Processing in Sensor Networks - IPSN '12 (p. 161). New York, New York, USA: ACM Press.
- Burri, N., von Rickenbach, P., & Wattenhofer, R. (2007). **Dozer: Ultra-Low Power Data Gathering in Sensor Networks**. 2007 6th International Symposium on Information Processing in Sensor Networks, 450–459.
- Ferrari, F. and Zimmerling, M. and Thiele, L. and Saukh, O. (2011). **Efficient Network Flooding and Time Synchronization with Glossy.** In *10th International Conference on Information Processing in Sensor Networks (IPSN 2011)* (pp. 73–84). IEEE.

Further Reading

- Sommer, P., & Wattenhofer, R. (2009). **Gradient Clock Synchronization in Wireless Sensor Networks**. Information Processing in Sensor Networks, 2009. IPSN 2009. International Conference on, 37 – 48.
- Lenzen, C., Sommer, P., & Wattenhofer, R. (2009). **Optimal clock synchronization in networks.** Proceedings of the 7th ACM Conference on Embedded Networked Sensor Systems SenSys 09, 225.
- F. Sutton, B. Buchli, J. Beutel, and L. Thiele: **Zippy: On-Demand Network Flooding**. Proc. ACM SenSys 2015.
- M. Woehrle, J. Beutel, R. Lim and L. Thiele: **Power monitoring and testing in Wireless Sensor Network Development**. Proceedings DCOSS, June 2008.
- Matthias Woehrle, Kai Lampka and Lothar Thiele: **Exploiting timed automata for conformance testing of power measurements.** Proc. Formal Modeling and Analysis of Timed Systems 2009, p. 275-290, September 2009.
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- Levis, P., Lee, N., Welsh, M., & Culler, D. (2003). **TOSSIM: accurate and scalable simulation of entire TinyOS applications**. In Proceedings of the first international conference on Embedded networked sensor systems - SenSys '03 (p. 126). New York, New York, USA: ACM Press.

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- Hester, J., Scott, T., Sorber, J. (2014): **Ekho: Realistic and Repeatable Experimentation for Tiny Energy-Harvesting Sensors**. In Proceedings of the 12th ACM Conference on Embedded Network Sensor Systems - SenSys '14. New York, New York, USA: ACM Press.
- J. Hester, L. Sitanayah, J. Sorber: T**ragedy of the Coulombs: Federating Energy Storage for Tiny, Intermittently-Powered Sensors**. Proceedings of the 13th ACM Conference on Embedded Networked Sensor Systems, pages 5-16, ACM New York, 2015.