

ECES 831 Ad Hoc and Sensor Networks

2:00 PM - 3:20 PM

302 Zimmer Hall

Catalog Data: **20-ECES-831 Ad Hoc and Sensor Networks:** Ad hoc networks, sensor networks, potential applications, broadcasting, multicasting, geo-casting, Wireless LANs and PANs, Impact of Directional Antennas, Security, heterogeneous networks.

Textbook: *Ad hoc and Sensor Networks - Theory and Applications*, by Carlos Cordeiro and Dharma P. Agrawal, World Scientific Publications, March 2006, ISBN 981-256-681-3.

Coordinator: Dharma P. Agrawal

Goals: Examine emerging technologies in Wireless Ad hoc and Sensor Networks

Prerequisites ECECS 797: Introduction to Wireless and Mobile Systems
by topic:

Grading:

1. Midterm in the class 40%
2. Simulation Project
 1. Show the demo in the sixth week. 20%
 2. Modify the demo by adding new features and show the demo again in the ninth week 15%
 3. Simulation report 5%
3. Survey Write up 15%
4. Homework 5%

Audit: Not allowed.

Course Contents:

1. **Introduction:** Communication puzzle, Applications of MANETs, Challenges, and Course organization.
2. **Unicasting:** Topology-based versus position-based approaches, Topology-based routing protocols, **Position**-based routing, Other routing protocols.
3. **Broadcasting, Multicasting and Geocasting:** and Broadcast storm. Multicasting, and Geocasting.
4. **Wireless LANs:** Why wireless LANs, Transmission Techniques, Medium Access Control Protocol Issues, IEEE 802. 11 Standard for wireless LANs, Enhancements to IEEE 802. 11 MAC, and Hiperlan/2 Standard for wireless LANs.
5. **Wireless PANs:** Why wireless PANs, Bluetooth technology, Enhancements to Bluetooth, IEEE 802. 15 working group for WPANs, Comparison between WPAN systems, and WLANs versus WPANs.
6. **Directional Antenna Systems:** Antenna concepts, Evolution of directional antenna

systems, Advantages of using directional antennas, Directional antennas for ad hoc networks, Protocol issues on the use of directional antennas, Broadcasting, Medium access control, Routing, and Protocols.

7. **TCP over Ad Hoc:** TCP protocol overview, TCP and MANETs, and Solutions for TCP over Ad hoc.
8. **Wireless Sensor Networks:** Mica Motes, Sensing and Communications range, Energy consumption, clustering of sensors, Different Applications, Body area network
9. **Information Retrieval in Sensor Networks:** Classification of sensor networks, Architecture of sensor networks, Physical layer, MAC layer, Routing layer, High-level application layer support, Adapting to the inherent dynamic nature of WSNs.
10. **Security:** Distributed systems security, Security in ad hoc networks, Key management, Secure routing, Cooperation in MANETs, and Intrusion detection systems.
11. **Integrating MANETs with WLANs and Cellular Networks:** Ingredients of a heterogeneous architecture, protocol stack, comparison of the integrated architecture, conclusions and future directions

Class Schedule:

March 26,28, and April 2 , 2007	Introduction, Routing in Ad hoc Networks
April 4 and 9	Multicasting, Broadcasting, and Geocasting
April 11	LANs
April 16, 18, 23, 25, and 30	Sensor Networks
April 16, Dr. Mikhail Nesterenko, Kent State	Sensor networks introduction: architecture and applications
April 18, Dr. Mikhail Nesterenko, Kent State	Radio propagation and routing in sensor networks: problems and solutions
April 23, Dr. Bin Wang Wright State	Over the radio reprogramming
April 25, Dr. Prasun Sinha, Ohio State	MAC Protocols in Sensor Networks BMAC: http://www.polastre.com/papers/sensys04-bmac.pdf , SMAC: http://www.isi.edu/~weive/pub/smac_ton.pdf , CMAC: http://www.cse.ohio-state.edu/~prasun/publications/conf/secon07-cmac.pdf
April 30, May 2, and 7	PANs
May 9	Midterm Examination
May 14 and 16	Directed Antennas
May 21	TCP
May 23 and 30	Security

List of Survey Topics

1. Body area networks
2. Bio-sensors: Needs and objectives
3. Applications of wireless sensor networks in Controlled Environments
4. Applications of self-organizing sensor networks
5. Object Tracking using sensor networks
6. Unconventional use of sensor networks

7. Cross Layer Activity Management in sensor network
8. Extensible Authentication Protocol (EAP) and IEEE 802. 1x
9. Accuracy and efficiency of location determination in wireless sensor networks
10. Efficient key management in sensor networks
11. Need for heterogeneity in wireless sensor networks
12. Query Execution in sensor networks
13. Usefulness of multiple radios in Sensor Networks
14. Energy efficient MAC protocols for wireless mobile networks and sensor networks
15. Energy efficient Routing protocols for wireless mobile networks and sensor networks
16. Forming aggregation scheme in a sensor network connected as mesh, hex and triangular schemes
17. Approximating traffic in a Mesh Network
18. Impact of partitioning of a Mesh Network on the network performance
19. Modeling of a Mobile mesh network
20. Impact of agile and cognitive radios on wireless communication
21. Multiple packet receiving schemes in ad hoc networks
22. TCP in Wireless Environments: Problems and solutions
23. Unsaturated Capacity of Ad hoc Networks
24. Optimization of Wireless Network Security
25. Channel Assignment in a multi-radio multi-channel Wireless Mesh Network
26. Link scheduling in a multi-channel Wireless Mesh Network
27. Using Directional Antennas in Ad Hoc & mesh networks
28. Mesh networking WPANs and WMANs
29. QoS-aware routing in ad hoc & mesh networks
30. Data integrity in ad hoc & sensor networks

List of Simulation Topics

1. **DRP: An Efficient Directional Routing Protocol for Mobile Ad Hoc Networks** by H. Gossain, T. Joshi, C. De Morais, and D. P. Agrawal, "*IEEE Transactions on Parallel and Distributed Systems*," Vol. 17, No. 12, December 2006.
2. **Maximal Lifetime Scheduling for Sensor Surveillance Systems with K Sensors to One Target** by H. Liu, P. Wan and X. Jia, "*IEEE Transactions on Parallel and Distributed Systems*," Vol. 17, No. 12, December 2006.
3. **An Adaptive Data Dissemination Strategy for Wireless Sensor Networks** by S. Selvakennedy and S. Sinnappan, "*International Journal of Distributed Sensor Networks*," Vol. 3, No. 1, 2007.
4. **A Search Space reduction Algorithm for Improving the Performance of a GA-based QoS Routing Method in Ad Hoc Networks** by L. Barolli, M. Ikeda, G. De Marco, A. Durresti, A. Koyama, and J. Iwashige, "*International Journal of Distributed Sensor Networks*," Vol. 3, No. 1, 2007.
5. **Anonymous Routing for Mobile Wireless Ad Hoc Networks** by A. Durresti, V. Paruchuri, M. Durresti, and L. Barroli, "*International Journal of Distributed Sensor Networks*," Vol. 3, No. 1, 2007.
6. **Cooperative Routing for Distributed Detection in Large Sensor Networks** by Y. Sung, S. Misra, L. Tong, and A. Ephremides, "*IEEE Journal on Selected Areas in*

- Communications*,” Vol. 25, No. 2, February 2007
7. **Troubleshooting Wireless Mesh Networks** by L. Qiu, P. Bahl, A. Rao, and L. Zhou, “*Computer Communication Review*,” Vol. 36, No. 5, October 2006.
 8. **OMAR: Utilizing Multiuser Diversity in Wireless Ad Hoc Networks** by J. Wang, H. Zhai, Y. Fang, J. M. Shea, and D. Wu, “*IEEE Transactions on Mobile Computing*,” Vol. 5, No. 12, December 2006.
 9. **RBR: A Region-Based Routing Protocol for Mobile Nodes in Hybrid Ad Hoc Networks** by R. Teng, “*IEEE Communications Magazine*,” Vol. 44, No. 11, Nov. 2006.
 10. **Energy Minimization for Real-Time Data Gathering for Wireless Ad Hoc Networks** by Y. Yu, V. K. Prasanna, and B. Krishnamachari, “*IEEE Transactions on Wireless Communications*,” Vol. 5, No. 11, November 2006.
 11. **Joint Optimization of Transmit Power-Time and Bit Energy Efficiency in CDMA Wireless Sensor Networks** by T. Shu, M. Krunz, and S. Vrudhula, “*IEEE Transactions on Wireless Communications*,” Vol. 5, No. 11, November 2006.
 12. **Cross-Layer Design for Lifetime Maximization in Interference-Limited Wireless Sensor Networks** by R. Madan, S. Cui, S. Lall, and A. Goldsmith, “*IEEE Transactions on Wireless Communications*,” Vol. 5, No. 11, November 2006.
 13. **A MAC-Layer Retransmission Algorithm Designed for the Physical-Layer Characteristics of Clustered Sensor Networks** by Q. Tian and E. J. Coyle, “*IEEE Transactions on Wireless Communications*,” Vol. 5, No. 11, November 2006.
 14. **DUCHA: A New Dual-Channel MAC Protocol for Multihop Ad Hoc Networks** by H. Zhai, J. Wang, and Y. Fang, “*IEEE Transactions on Wireless Communications*,” Vol. 5, No. 11, November 2006.
 15. **Joint Channel Assignment and Routing for Throughput Optimization in Multiradio Wireless Mesh Networks** by M. Alicherry, R. Bhatia, and L. E. Li, “*IEEE Journal on Selected Areas in Communications*,” Vol. 24, No. 11, November 2006.
 16. **Quality-Aware Routing Metrics for Time-Varying Wireless Mesh Networks** by C. E. Koksal and H. Balakrishna, “*IEEE Journal on Selected Areas in Communications*,” Vol. 24, No. 11, November 2006.
 17. **Localized Operations for Distributed Minimum Energy Multicast Algorithm in Mobile Ad Hoc Networks** by S. Guo, and O. Yang, “*IEEE Transactions on Parallel and Distributed Systems*,” Vol. 18, No. 2, February 2007.
 18. **Mobility Limited Flip-Based Sensor Networks Deployment** by S. Chellappan, X. Bai, B. Ma, D. Xuan, and C. Xu, “*IEEE Transactions on Parallel and Distributed Systems*,” Vol. 18, No. 2, February 2007.
 19. **Balancing Push and Pull for Efficient Information Discovery in Large-Scale Sensor Networks** by X. Liu, Q. Huang, and Y. Zhang, “*IEEE Transactions on Mobile Computing*,” Vol. 6, No. 3, March 2007.
 20. **Cross-Layer Collaborative in-Network Processing in Multihop Wireless Sensor Networks** by Y. Tian, and E. Ekici, “*IEEE Transactions on Mobile Computing*,” Vol. 6, No. 3, March 2007.
 21. **Energy-Efficient node-to-node authentication and communication confidentiality in Wireless Sensor Networks** by R. Di Pietro, L. V. Mancini, and A. Mei, “*Wireless Networks*,” Vol. 12, No. 6, December 2006.
 22. **Energy balanced data propagation in Wireless Sensor Networks** by C. Efthymiou, S. Nikolettseas, and J. Rolim, “*Wireless Networks*,” Vol. 12, No. 6, December 2006.

23. **PANDA: A novel mechanism for Flooding Based Route Discovery in Ad Hoc Networks** by J. Li and P. Mohapatra, "*Wireless Networks*," Vol. 12, No. 6, Dec. 2006.
24. **DART: Dynamic Address Routing for Scalable Ad Hoc and Mesh Networks** by J. Eriksson, M. Faloutsos, and S. V. Krishnamurthy, "*IEEE/ACM Transactions on Networking*," Vol. 15, No. 1, February 2007.
25. **A Cross-Layer Architecture of Wireless Sensor Networks for Target Tracking** by L. Song and D. Hatzinakos, "*IEEE/ACM Transactions on Networking*," Vol. 15, No. 1, February 2007.
26. **QoS-Aware TDMA for End-to-End Traffic Scheduling in Ad Hoc Networks** by D. D. Vergados, D. J. Vergados, C. Douligeris, and S. L. Tombros, "*IEEE Wireless Communications*," Vol. 13, No. 5, October 2006.
27. **CodeCast: A Network-Coding-Based Ad Hoc Multicast Protocol** by J-S. Park, M. Gerla, D. S. Lun, Y. Yi, and M. Medard, "*IEEE Wireless Communications*," Vol. 13, No. 5, October 2006.
28. **Energy-aware On-Demand Routing Protocols for Wireless Ad Hoc Networks** by B. Zhang and H. T. Mouftah, "*IEEE Wireless Communications*," Vol. 13, No. 5, October 2006.
29. **Platform based Design for Wireless Sensor Networks** by A. Bonivento, L. P. Carloni, and A. Sangiovanni-Vincentelli, "*Mobile Networks and Applications*," Vol. 11, No. 4, August 2006.
30. **Intrusion Detection for Routing Attacks in Sensor Networks** by C. E. Loo, M. Y. Ng, C. Leckie, and M. Palaniswami, "*International Journal of Distributed Sensor Networks*," Vol. 2, No. 4, December 2006.
31. **Distributed Self-Tuning of Sensor Networks** by A. Karnik, A. Kumar, and V. Borkar, "*Wireless Networks*," Vol. 12, No. 5, October 2006.
32. **A Randomized Energy-Conservation Protocol for Resilient Sensor Networks** by F. Ye, H. Zhang, S. Lu, L. Zhang, and J. Hou, "*Wireless Networks*," Vol. 12, No. 5, October 2006.
33. **Online Data Gathering for Maximizing Network Lifetime in Sensor Networks** by W. Liang, and Y. Liu, "*IEEE Transactions on Mobile Computing*," Vol. 6, No. 1, January 2007.
34. **SoftMAC: Layer 2.5 Collaborative MAC for Multimedia Support in Multihop Wireless Networks** by H. Wu, Y. Liu, Q. Zhang, and Z. -L. Zhang, "*IEEE Transactions on Mobile Computing*," Vol. 6, No. 1, January 2007.
35. **Inner-Circle Consistency for Wireless Ad Hoc Networks** by C. Basile, Z. Kalbarczyk, and R. K. Iyer, "*IEEE Transactions on Mobile Computing*," Vol. 6, No. 1, January 2007.
36. **Route Reservation in Ad Hoc Wireless Networks** by S. Panichpapiboon, G. Ferrari, N. Wisitpongphan, and O. K. Tonguz, "*IEEE Transactions on Mobile Computing*," Vol. 6, No. 1, January 2007.
37. **Wormhole-Based Antijamming Techniques in Sensor Networks** by M. Cagalj, S. Capkun, and J. -P. Hubaux, "*IEEE Transactions on Mobile Computing*," Vol. 6, No. 1, January 2007.
38. **SyncWUF: An Ultra Low-Power MAC Protocol for Wireless Sensor Networks** by X. Shi and G. Stromberg, "*IEEE Transactions on Mobile Computing*," Vol. 6, No. 1,

January 2007.

Computer Usage: For simulation project.

Outcomes: Engineering Science: 50%, Engineering Design: 50%

Prepared by: Dharma P. Agrawal, D. Sc. **Date:** March 25, 2007