CSE 6344

Advanced Topics In Networking

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More Information

g Instructors: Chengzhi Li

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   § Office hour:

      • Tuesday & Thursday 4:00-5:00 pm

      • Drop by if door is open

g Class:

   i Time   : Tuesday & Thursday 7:00-8:00 pm

   i Location : WH 308

   i TA   : Shufeng Zhou

First Thing to Do !

g Everything is in the Web

   i Syllabus, course information, schedule ......

    http://ranger.uta.edu/~li/uta-classes-2005.html

   i Course materials
- Latest research papers selected from the premier journals and conference proceedings

    http://ieeexplore.ieee.org/Xplore/DynWel.jsp

Course Requirements

g Reasonable background in Wired/Wireless Networks

- § <u>OSI</u> (open systems interconnection) reference model
- § Wireless LANs : IEEE 802.11 a, b, e, g
- § Cellular networks: cdma2000 and W-CDMA
- § Mobile Wireless Ad-Hoc Networks
- § ......

g Comfortable with Math

- § Calculus & Linear Algebra
- § Optimization
- § Probability & Stochastic Processes

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Course Work (1)

- **g** Every student needs to do one presentations (begin at March. 8)
  - § Each presentation will cover one paper
  - § Never read only the paper, references as well
  - § Students need to select the paper before Feb. 1
  - § Students need to sign up first presentation schedule before Feb. 7
  - § Students need to discuss the paper with me
    - § Two weeks earlier
    - § By the time, students should fully understand the paper and related references
  - § Students need to discuss the slides with me
    - § One week earlier

- **g** For each presented paper, all students needs to hand in a simple reading summary (one paragraph) which contains:
  - § What is the problem the paper wants to solve?
  - § What is the background and related work?
  - § What are the new idea and contribution of the paper?
  - § What is the weakness in the paper?
  - § What are the potential future research issues ?

- **g** Students should participate class discussions and attendance is required

Course Work (2)

g Term project

- § Survey project or research project
- § Performed in small group which consists of 1~2 students.
- § Students are highly encouraged to propose their topics
- § Suggested topics will be provided before Feb. 8
- § Students need to find their partner before Feb. 12
- § Students need to submit the project pre-proposal before March 1
- § Student need to finalize their project proposal before March. 20
- § Final project report is due May. 6

Grading Policy

g Presentation   25%

g Reading summaries   15%

g Project   25%

g Final Exam   15%

g Class participation & homework 20%

g 85-100: A;   70-84: B; 60-69: C; < 60: F

Selected Topics

1. Vision and Challenges

2. PHY layer

3. Link Layer

4. Network Layer

5. Transport Layer

6. Application Layer

7. Wireless Channel Capacity

8. Ad-Hoc Wireless Network Capacity

9. Caution Perspective

1. Vision and Challenges

§ **"Cross-Layer Design for Wireless Networks"**, S. Shakkottai, T. S. Rappaport, and P. C. Karlsson, in IEEE Communications Magazine, Vol. 41, No. 10, 2003

§ **"QoS in Mobile Ad-Hoc Networks"**, P. Mohapatra, J. Li, and C. Gui, in IEEE Wireless Communications, Vol. 10, No. 3, 2003

§ **"Design Challenges for Energy-Constrained Ad-Hoc Wireless Networks"**, A. J. Goldsmith and S. B. Wicker, in IEEE Wireless Communications, Vol. 9, No.4, 2002

§ **"Wireless Communications: Past Events and A Future Perspective"**, T. S. Rappaport, A. Annamalai, R. M. Burhrer, and W. H. Tranter, in IEEE Communications Magazine, May, 2002

§ **"A Survey of Energy Efficient Network Protocols for Wireless Networks"**, C. Jones, K. Sivalingam, P. Agrawal, and J. Chen, 2002

1. PHY Layer

g "Cross-Layer Combining of Adaptive Modulation and Coding with Truncated ARQ over Wireless Links", in IEEE Trans. On Wireless Communications, 2004

- § 3G cellurlar networks
- § Nakagami-m fading channel
- § New formula for packet error rate
- § Combine AMC at physical layer with ARQ at Link layer to improve the performance under delay and packet error rate constraints

g "Goodput Analysis and Link Adaptation for IEEE 802.11a Wireless Lans", D. Qiao, S. Choi, and K. G. Shin, IEEE Trans. On Mobile Computing, Oct., 2002

- § IEEE 802.11a (wireless LANs)
- § Additive Gaussian White Noise channel
- § Two state Markov chain model
- § Combine AMC and IEEE 802.11 MAC (DCF) to improve goodput performance

2. Link Layer

- **g** "MACA - A New Channel Access Method for Packet Radio", in the proceedings of the 9th ARRL Computer Networking Conference, London, Ontario, Canada, 1990.

- **g** " MACAW: A Media Access Protocol for Wireless LANs'', V. Bharghavan, A. Demers, S. Shenker, and L. Zhang, *ACM Sigcomm '94,* London, UK.

- **g** "Dual busy tone multiple access (DBTMA): A multiple access control scheme for ad hoc networks", J. Deng and Z. Haas, in IEEE Trans. on Communications, vol. 50, no. 6, 2002

- **g** "Power-Controlled Multiple Access Schemes for Next-Generation Wireless Packet Networks", N. Bambos and S. Kandukuri, IEEE Wireless Communication, June, 2002
  - § Next-G cellular networks
  - § Power control at MAC layer to meet delay bound
  - § Capture the trade-off of packet delay vs. transmission power
  - § Key mechanism : increasing transmission power when packet approaches its delay constraint to enhance QoS

- **g** "Cross-Layer Scheduling for Power Efficiency in Wireless Sensor Networks", M. L. Sichitiu, IEEE INFOCOM 2004
  - § Sensor networks
  - § Combine scheduling and routing to minimize energy consumption

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4. Network Layer

g "Supporting service differentiation for real-time and best effort traffic in stateless wireless ad-hoc networks (SWAN)", IEEE Trans. On Mobile Computing, July-September, 2002

- § Wireless ad-hoc networks
- § Real-time and best effort traffic
- § Use the info from MAC layer to do rate control at network layer for supporting real-time and best effort traffic
- § First service differentiation in mobile ad hoc networks

g "A Comprehensive Minimum Energy Routing Scheme for Wireless Ad-Hoc Networks", J. Zhu, C. Qiao, and X. Wang, IEEE INFOCOM 2004

- § Wireless ad-hoc networks
- § Combine routing at network layer and power control at physical layer for energy efficient routing

5. Transport Layer

g "TCP Performance in Wireless Access with Adaptive Modulation and Coding", in the Proceeding of IEEE ICC 2004
- § End-to-end TCP with last wireless hop
- § Combine TCP at Transport layer and AMC at Physical layer to improve TCP performance

g "ATL: An Adaptive Transport Layer Suite for Next-Generation Wireless Internet", O. B. Akan and I. F. Akyildiz IEEE Journal on Selected Areas in Communications June, 2004
- § Next-G including WLAN, Cellular, and Satellite networks
- § New adaptive transport layer suit including adaptive transport protocol and adaptive rate control protocol based on lower layers' info

6. Application Layer

g "Video Streaming over Wireless LANs: A Cross-Layer Approach", S. Krishnamachari, M. Schaar, S. Choi, and X. Xu, 2003

7. Wireless Channel Capacity

g "Effective Capacity: A Wireless Link Model for Support of Quality of Service", in IEEE Tran. On Wireless Communications, July, 2003

g Remark:

   v Shannon Capacity Formula

$$C = B \times \text{Log}_2(1 + \text{SNR})$$

      § This model built a great foundation for information theory

      § Many algorithms designed for physical layer are based on it

      § This model is in bit level, and difficult to be used for algorithm and protocol design in upper layer because the basic unit at upper layer is packet instead of bit

      § The goal of the selected papers to try to create similar channel capacity model in packet level at the upper layers to build a foundation for QoS provisioning

8. Capacity of Wireless Networks

g   "Mobility increases the capacity of ad-hoc wireless networks", M. Grossglauer and D. N. Tse, INFOCOM 2002. (best paper award)

Remark: P. R. Kummar in famous paper "Capacity of Wireless Networks" pointed out in optimal circumstances, the throughput between arbitrary two nodes is proportional to 1/sqrt(n) for a wireless network with n nodes. This result implies that wireless networking is only suitable for small scale, but not suitable for the large scale. The contribution of this best award paper is it pointed out by exploiting the mobility, in ideal situation, the throughput between two nodes can be constant and independent of the network size

9. Cautionary Perspective

g "A Cautionary Perspective on Cross Layer Design", V. Kawadia and P. R. Kumar, 2003 submitted to IEEE Wireless Communications.

Remark: this paper points out

§ short term vision must be avoided when optimizing the performance of wireless networks by cross-layer adaptation

§ caution must be exercised before leaping into cross-layer design to avoid unintended consequences

Why Take This Course

§   Learn the state-of-the-art

§   Train the ability to do original research in academic or industry

To Do & Not To Do

q To Do
- Think a lot
- Work hard
- Have fun

q Not To Do
- Lazy
- Worry about grades

Summary

g Wireless Networks
- § Very active and evolving research field
- § Plenty of interesting research problems

g We will learn a lot in following classes
- § Understand the state of the art
- § New ideas and new results
- § New ways for wireless networking

g It will be Very Rewarding