Communication Networks
The University of Kansas EECS 780
Spring 2009

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The University of Kansas

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http://www.ittc.ku.edu/~jpps/courses/nets

AE.1  Administrivia
    AE.1.1  Schedule
    AE.1.2  Prerequisites and description
    AE.1.3  Instructor information and correspondence
    AE.1.4  Grading and student expectations

AE.2  Ethics and academic integrity

AE.3  Course outline
Communication Networks

AE.1 Administrivia

AE.1.1 Schedule

AE.1.2 Prerequisites and description

AE.1.3 Instructor information and correspondence

AE.1.4 Grading and student expectations

AE.2 Ethics and academic integrity

AE.3 Course outline

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Course Information

High-Level Schedule

- Lecture: 4 Regents Center – Edwards Campus
  - Wed. 18:10 – 21:00
- Discussion: 368 Regnier – Edwards Campus
  - or different room as posted
  - meets occasionally as needed
    - labs sessions and help not scheduled as part of lecture
    - rescheduled lectures and review sessions
    - do not come unless we’ve explicitly scheduled a session!
  - Mon. 19:10 – 21:00
- 21 Jan. – 13 May
  - three sectional exams plus final (13 May)
  - no class 18 Mar. due to spring break
Course Information

Cancellation and Rescheduling

- Cancellation due to weather
  - official closings unlikely
    - follow media announcements
  - if I can’t make it from Lawrence
    - email to class list by 15:00
    - phone message with Edwards reception +1 913 897 8400

- Rescheduling due to my travel
  - I try very hard to avoid rescheduling class
  - project meetings & conferences sometimes interfere
  - this is the cost of an instructor who is active in research
  - rescheduled lectures held Mon. during discussion period

Communication Networks

AE.1.2 Prerequisites and Description

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Communication Networks
EECS 780 Student Requirements

- Graduate students
- Undergraduate students
  - senior standing \textit{required}
  - B average \textit{required}

Communication Networks
EECS 780 Prerequisites

- Basic working knowledge of:
  - computer systems
  - Internet
  - probability and statistics (EECS 461 equivalent)
  - programming skills (EECS 168 equivalent)
- EECS780 is an introductory networking course
  - but \textit{intensive} in \textit{breadth and depth} of material
  - lectures may seem like “drinking from a fire hose”
    - ask questions and keep it interactive; I’ll adapt
    - much of the lecture notes for reference
      - you don’t need to memorise longs lists of nitty details
Networking Courses
MSIT Edwards Courses

- **EECS 780**: Communication Networks
  - spring at Edwards
  - only one of {EECS 563 | EECS 663 | EECS 780} for credit
  - prerequisite for...
- **EECS 881**: High-Speed Networking
  - fall in even numbered years at Edwards
- **EECS 882**: Mobile and Wireless Networking
  - fall in odd numbered years at Edwards
- **EECS 712**: Network Security

Networking Courses
Selected Lawrence Networking Courses

- **EECS 563**: Introduction to Communication Networks
  - fall in Lawrence
- **EECS 766**: Resource Sharing for Broadband Access Networks
- **EECS 745**: Implementation of Networks
- **EECS 864**: Multiwavelength Optical Networks
- **EECS 888**: Internet Routing Architectures
- **EECS 983**: Resilient and Survivable Networking
  - spring in even numbered years Lawrence
Communication Courses

Selected Lawrence Communications Courses

- EECS 861: Random Signals and Noise
- EECS 862: Digital Communication Systems
- EECS 863: Analysis of Comm. Networks
- EECS 865: Wireless Communication Systems
- EECS 869: Error Control Coding
- EECS 964: Simulation of Comm. Systems
- EECS 965: Detection and Estimation Theory
- EECS 967: Mathematical Optimization with Communications Applications
- EECS 969: Information Theory

Communication Networks

Official EECS 780 Course Description

Comprehensive in-depth coverage of communication networks with emphasis on the Internet and the PSTN (wired and wireless). Extensive examples of protocols and algorithms are presented at all levels, including: client/server and peer-to-peer applications; session control; transport protocols, the end-to-end arguments and end-to-end congestion control; network architecture, forwarding, routing, signalling, addressing, and traffic management; quality of service, basic queuing (basic M/M/1 and Little's law) and multimedia applications; LAN architecture, link protocols, access networks and MAC algorithms; physical media characteristics and coding; network security and information assurance; network management.

Prerequisites: Basic working knowledge of computer systems, the Internet, and probability and statistics; basic programming skills.

*Credit may be received for only one of EECS 563, EECS 663, or EECS 780*
Communication Networks

Summary of EECS 780 Course Description

• Introductory intensive graduate-level course
  – concepts and examples of systems and protocols
  – mostly non-mathematical
  – some basic queuing theory

• Emphasis on
  – Internet
  – PSTN (public switched telephone network)
  – introduction to mobile and wireless networks

• Top-down approach
  – generally following the structure of *Kurose and Ross*
  – additional material from *Sterbenz and Touch*
  – additional material from class notes and readings

Communication Networks

AE.1.3 Instructor Information, Correspondence

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Instructor Information

Background

- Dr. James P.G. Sterbenz
  - current positions
    - Associate Professor, KU Lawrence, US
    - Visiting Professor of Computing, Lancaster University, UK
  - past research and management positions
    - UMass, BBN Technologies, GTE Laboratories, IBM Research
  - academic background
    - D.Sc., Washington University in St. Louis, 1991
  - research interests
    - survivable and resilient networking
    - autonomic, programmable, and active networks
    - mobile wireless networking
    - high-speed networking and system architecture

Contact Modes

- Web: check the class Web pages first
  - important announcements at top of 2008 page
  - detailed schedule
- Email: generally the best means of communication
  - many issues and questions can be quickly resolved
  - use to arrange other appointments
- Interactive
  - skype chat
  - phone
- Office hours
  - face-to-face contact
Instructor Information
Office Hours

- Wed. 16:00 – 18:00
  - unless advised otherwise due to meetings or travel
- 125U Regents Center
- Or by appointment
  - email, chat, or call to arrange in advance
  - chat or call before dropping in unless already on campus
  - Wed: typically on Edwards campus in afternoon
  - MTTF: typically in Lawrence if not travelling
    - 145 Nichols: research office
    - 3036 Eaton: teaching and undergraduate advising office

GTA Information
Background and Office Hours

- Egemen K. Çetinkaya
  - PhD student, University of Kansas EECS
- Office hours: Wed. 17:00 – 18:00
  - Regnier 368 (lab room) or Regnier 125U (instructor office)
  - unless advised otherwise due to meetings or travel
- Contact information
  - email
    - ekc@ittc.ku.edu
  - phone
    - 248 Nichols office: +1 785 864 7450
    - mobile: +1 785 550 4654
Instructor and GTA Information
Contact: Email Address

- Email: jgps@eecs.ku.edu or ekc@ittc.ku.edu only
  - begin subject with exact string "EECS780 -"
  - email to other addresses will likely be misfiltered and unread
  - no space between "EECS" and "780"
  - blank space between "780" and hyphen
  - I generally check email daily
    - email is unreliable; retry if no reply within 48 hours
    - if quick reply is needed feel free to skype chat or phone

Instructor Information
Contact: Email Address

- Email with meaningful subject lines
  - bad
    
    Subject: Hi!
    Subject: regarding class
  - good
    
    Subject: EECS780 - need help understanding AIMD
Electronic Mail
Netiquette: Sender Identification

• Configure email client with your name in ISO-Latin
  – e.g. Ima K.U. Student <ima.student@eecs.ku.edu>
  – do not use CJK (Chinese, Japanese, Korean) encodings
    – appear as gibberish to most users
  – Define a meaningful signature (.sig)
    – name, affiliation, telephone number, URL if you have one
    – max. of 4 lines (not including separator dashes)
    – max of 72 characters/line, e.g.

Electronic Mail
Netiquette: Formatting

• Email was originally text-only with no formatting
  – many people still like it that way!
    • some people still use text only clients
    • increasing use of PDAs
  – not all clients are MS Outlook!
• Unless pre-negotiated with the recipient:
  – use plain text with no formatting
    • some email clients have formatting on by default
    • some misconfigured (MS-Exchange) servers format anyway
  – do not send email as HTML
  – do not embed images
Electronic Mail
Netiquette: Content and Attachments

- **Content issues**
  - use meaningful subject lines
  - spellcheck (most modern clients do this)
  - *think* before you send

- **Simple emails should not be sent as attachments**
  - e.g. MS-Word document containing “where are you now?”

- **Do not send very large attachments unless**
  - receiver is able to handle them (broadband access)
  - small enough to pass relay & server limits (typ. <10 MB)

Electronic Mail
Netiquette: Professionalism

- **Email is like conversation, writing, and attire**
  - adapt style to context
  - academic and professional is more formal than with friends

- **Style**
  - plain text, no embedded images
  - limit jargon and emoticons to someone you know well
  - proofread and *think* before you send

- **Proofread and *think before you send!***
Electronic Mail
Netiquette: Professionalism

- Avoid free email accounts
  - e.g. hotmail, yahoo
- Gives you a very unprofessional appearance
  - frequently auto-append advertisements
- Frequently spam-blocked
- Use academic or corporate email addresses
  - for professional correspondence

Electronic Mail
Netiquette: Professionalism Examples

To: James Sterbenz <jpgs@eecs.ku.edu>
From: Ima <cool_dude@stupidmail.com>
Subject: need a job!!!

i'm new at KU and really like it @
i'm interested in everything and
am bombing this email to all KU
professors. i've stopped by your offic
in Eaton but your never there!!! @
do you even have office hours
dude? LOL! just tell me when i can
dropby too learn what you do
KU THERE????!!

cu later,
ima

What's wrong?

Get your free email at Stupidmail.com!

Eat at Joe's: 1234 Mass, Lawrence, KS
To: James Sterbenz <jpgs@eecs.ku.edu>
From: Ima <cool_dude@stupidmail.com>
Subject: need a job!!!

I'm new at KU and really like it. I'm interested in everything and am bombing this email to all KU professors. I've stopped by your office in Eaton but you're never there!!! Do you even have office hours dude? LOL! Just tell me when I can drop by to learn what you do.

cu later,
ima

Get your free email at Stupidmail.com!

Eat at Joe's: 1234 Mass. Lawrence, KS

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To: James Sterbenz <jpgs@eecs.ku.edu>
From: Ima Student <student@eecs.ku.edu>
Subject: Interest in ResiliNets group

Dear Professor Sterbenz,

I am a new M.S. student in the EECS department with interests in networking. I have looked at your Web pages and read the SUMOWN paper. I am very interested in this research and will come to the next ResiliNets group meeting on Friday. I would like to discuss the possibility of you becoming my advisor and want to understand if there are any funding opportunities.

Sincerely,
Ima Student

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Ima Student       EECS, Univ. of Kansas
student@eecs.ku.edu     +1 785 555 1212

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Student Information

Introductions

- Brief Introductions around the room
  - say who you are and why you are here
- Photos to help me learn your names
Student Information

Contact and Background

- Roster information to be filled in pass-around sheet
  - full name, nickname
  - employer if not full-time student
  - email for class distribution list
    - preferred and mandatory eecs.ku.edu address
  - phone numbers will only be used for urgent matters
    - day and evening
  - degree (BS, MS, PhD)
    - major (IT, CS, CoE, EE)
    - focus area if MSIT (Internet Engr., Info. Sec., Software Engr.)
    - option if MS (course, project, thesis)
    - advisor name (“none” if you don’t have one yet)

Course Information

Correspondence to Class

- Course information and notes
  - http://www.ittc.ku.edu/~jpgs/courses/nets
    - notes for each lecture will be posted in PDF
      - check for 2008 date and version on first page
    - navigate to subpage for Spring 2008 specific information
      - schedule and deadlines
  - http://www.ittc.ku.edu/~jpgs/courses
    - generic information
  - check regularly for updates
    - readings and assignments in schedule table in sub-page
    - "last updated" on bottom of page
Course Information
Correspondence to Class

• Class email list
  – all students are required by EECS to use eecs.ku.edu email
    • I’m willing to use other email addresses...
    • ...but only if they are relatively reliable
      – many free email accounts are not!
      – if there are problems I’ll change your entry to a .ku.edu address
    – check email regularly
    – check email every afternoon before class

• Telephone
  – I’ll only phone you if urgent

Instructor Information
Contact: Phone and Chat

• Contact information
  – phone
    • Edwards office: +1 913 897 8538
    • Lawrence Nichols office: +1 785 864 7890
    • Lawrence Eaton office: +1 785 864 8846
    • only if urgent (consider Δ time)
    • don’t call me at home unless emergency
    – skype: jpgsterbenz
    • ok to use chat judiciously when email not appropriate
      – send meaningful introduction message!
    • don’t use voice unless prearranged by chat
      – I frequently am not in a position to use headset/microphone
Communication Networks
AE.1.4 Grading and Student Expectations

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Course Information
Textbooks and Reading

• Required textbooks: you need them now
    • if you bought a used copy you’ll need to buy a content license
  – Sterbenz & Touch: High-Speed Networking
    • also used as main textbook in EECS 881

• Supplementary textbooks and monographs
  – provide alternative, in-depth, or background coverage
  – Reserve in Edwards and Spahr libraries

• Additional papers (a few are required reading)
  – supplement books
  – experience that will help you write papers
Course Information

Reading

• How hard is this class?
  – not a “killer class” in terms of homework and projects
  – but it is intellectually challenging with significant reading
• Required readings are mandatory
  – the textbooks are not just a reference
  – you won’t be able to use it on exams
• Reading must be done before corresponding class
  – you are doomed if you get behind on the reading
  – you are responsible for all required reading
    • may be on exams even if not covered in lecture
    • contributes to your class participation grade

Grades

• Grades: modified curve grouped by mode
  – based only on merit; not on:
    • employer reimbursement or lack thereof
    • immigration status or potential visa invalidation
    • probationary status at KU
  – qualitative meaning
    A: exceptional exam results and outstanding term paper
    B: mastery of material and solid term paper
      this is the basic expectation for a graduate student
    C: slacking but know basic material and marginal paper
    D: very poor performance on exams or paper
    F: nonperformance on exams or paper
      academic misconduct regardless of other grades
## Course Information

### Grade Contribution

- **Relative grade contribution**
  - 40% section exams
    - two at 13.33% each
    - third at 13.33% will be first half of final exam period
  - 15% comprehensive portion of final exam
  - 15% term paper
    - significant extra credit for *publishable* paper
  - 20% homework and Wireshark exercises
  - 10%: class participation
    - *this can make a letter difference in your final grade*
  - mandatory academic integrity quiz in second class
    - must be made up if you miss this class

### Exam Schedule and Weight

- **Section exams: 40%**
  - tentative schedule *subject to change*
    - academic integrity quiz on 30 Jan. (required to pass course)
    - exam 1 on 04 Mar.
    - exam 2 on 22 Apr. (I will be attending INFOCOM 2009)
    - exam 3 on 13 May (portion of final exam period)

- **Final exam: 15%**
  - comprehensive covering entire course
  - synthesis of multiple sections
  - portion of final exam period
Course Information

Exam Characteristics

- Closed book, no electronic devices
  - notify me *in advance* if you know you must miss
  - you will probably have to take the exam in advance
- Exams test *understanding of concepts*
  - not memorisation of facts that could be looked up
  - not focused on the ability to solve problems
  - this will be new to some of you!
- More exam information on
  [http://www.ittc.ku.edu/~jpgs/courses/exams.html](http://www.ittc.ku.edu/~jpgs/courses/exams.html)

Course Information

Exam Questions

- Exams consist of two types of questions
  - sufficient space given to properly and fully answer
- Short answer example (several per page):
  - example question:
    Compare the functionality of the link and transport layers.
Course Information

Exam Questions

- Exams consist of two types of questions
  - sufficient space given to properly and fully answer
- Short answer example (several per page):
  - example question:
    Compare the functionality of the link and transport layers.
- Long answer example (one per page):
  - example exam question:
    Sketch and label a packet flow diagram for stop-and-wait, go-back-n, and selective repeat. Explain the advantages and disadvantages of each scheme.

Answer Questions

- Answers must legibly fit in space provided
  - sufficient space given to properly and fully answer
  - be brief; points will be *deducted* for irrelevant information
    - and you will have a hard time finishing the exam
  - writing on back of page & deep into margins will be ignored
Example question:

Compare the functionality of the link and transport layers.

- Example correct answer (1 minute to write):
  Both the link and transport layer transfer data; the link layer hop-by-hop and the transport layer end-to-end.
Course Information
Exam Answers: How Not to Answer

- Example question:
  Compare the functionality of the link and transport layers.
  - example correct answer (1 minute to write):
    Both the link and transport layer transfer data; the link layer hop-by-hop and the transport layer end-to-end.
  - example poor answer (10 minutes to write):
    The link layer is layer 2 in the OSI model, shown in the figure. Examples of link layer protocols include Ethernet, 802.11, SONET, and HDLC. 802.11 was developed in as a replacement for Ethernet, and thus has similar frame structure, shown in Figure 2. Note that 802.11 has more MAC address fields than Ethernet. The reason for the additional address fields has to do with the operation of the 802.11 MAC. Actually I really don't know the answer to this question, but I did memorise a bunch of stuff on some of these protocols, so I hope that if I write enough that I will get some credit for this question and that if I bomb you with information you will find some reason to give me credit on this problem and so I'm just going to keep writing until time is called on this.

Course Information
Homework Assignments and Lab Exercises

- 20% of grade on homework and laboratory exercises
  - homework assignments give you problem solving experience
  - laboratory exercises give you practical experience
- Slacking on either will also hurt your exam scores
Course Information

Homework Assignments

- You **must** solve homework assignments individually
  - you may discuss problems and solution strategies
    - but should not walk away from discussion with written notes
    - nor engage in group homework solving
  - you must not use (illegal) copies of the solution manual
- Homework problem
  - show your work; answers alone will receive no credit
  - show all units, e.g. \( 10 \text{ [Mb/s]} \cdot 5 \text{ [\mu s]} = 5[b] \)
  - when asked explain *how* you reached your answer
- Homework submission requirements
  - [www.ittc.ku.edu/~jpgs/course/homework.html](http://www.ittc.ku.edu/~jpgs/course/homework.html)

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Course Information

Homework Assignment Submission

- Due at the beginning of class on the due date
  - usually Wed. – late assignments generally **not** accepted
    - unless prearranged, e.g. due to illness or business travel
- Submit homework either by:
  - bring hardcopy to class; keep a copy for yourself
  - email to ekc@ittc.ku.edu and cc: to jpgs@eecs.ku.edu
    - Subject: line **must** begin with the *exact string*
      "EECS780 - assignment " followed by assignment number
    - homework as MIME attachment in PDF
      - if you can’t generate PDF **now** is the time to gain the capability
Course Information

Laboratory Exercises

- Laboratory exercises to gain practical experience
  - Wireshark laboratories for protocol analysis
    - download Wireshark now for Kurose labs: www.wireshark.org
    - must explain what you did and not only submit screen shots
  - socket programming exercise
    - code must be commented and submitted electronically
  - introduction to network simulation with ns-3
    - scripts must be commented and submitted electronically
  - hands-on router configuration and TCP tracing

- You must solve laboratory assignments individually
  - unless otherwise instructed for group labs

Course Information

Laboratory Exercise Submission

- Due at the beginning of class on the due date
  - usually Wed. – late assignments generally not accepted
    - unless prearranged, e.g. due to illness or business travel

- Submit by email to ekc@ittc.ku.edu and cc: to jpgs@eecs.ku.edu
  - Subject: line must begin with the exact string “EECS780 - laboratory” followed by the lab type
  - report as MIME attachment in PDF
  - code as MIME attachment in plain text
Course Information
Term Paper

• 15% of grade based on term paper
• Purpose and scope:
  – research area of communication networks beyond class
  – technical in nature
    • may lead to MS thesis or PhD dissertation
    • may even lead to publication (significant extra credit)
  – either a
    • paper survey
    • based on an implementation or simulation project
  – gain technical writing and presentation experience

Course Information
Term Paper Submission

• Submit by term paper milestones to jpgs@eecs.ku.edu and cc: to ekc@ittc.ku.edu
  – Subject: line must begin with the exact string "EECS780 - term paper" followed by the milestone type
  – as MIME attachment in PDF
  – final presentation as MIME attachment in PowerPoint or PDF
• Submission requirements and templates at www.ittc.ku.edu/~jpgs/courses/writing-guide.html
Course Information

Term Paper Milestones and Tentative Schedule

<table>
<thead>
<tr>
<th>Milestone</th>
<th>Details</th>
<th>Due date</th>
</tr>
</thead>
<tbody>
<tr>
<td>Two ideas</td>
<td>2 ideas with 2 <em>complete</em> references each</td>
<td>16 Feb.</td>
</tr>
<tr>
<td>Proposal</td>
<td>Proposal with 5 <em>complete</em> references</td>
<td>09 Mar.</td>
</tr>
<tr>
<td>Outline</td>
<td>Draft outline with <em>no</em> body text and more refs.</td>
<td>30 Mar.</td>
</tr>
<tr>
<td>Draft paper</td>
<td>Mostly complete draft paper</td>
<td>29 Apr.</td>
</tr>
<tr>
<td>Presentation</td>
<td>Presentation to class and discussion</td>
<td>06 May</td>
</tr>
<tr>
<td>Final paper</td>
<td>Complete polished paper</td>
<td>07 May</td>
</tr>
</tbody>
</table>

- Series of milestones
  - flow control process and allow us to discuss progress
    - you will not do well if you wait until the last minute
  - timely submission part of final paper grade
  - milestones not meeting basic requirements not accepted

Sources of Literature: Library

- The Library
  - big building with books and paper journals: *use it!*
- Physically browsing is a wonderful way to brainstorm
  - Spahr Engineering Lib. TK numbers most relevant
  - Anschutz (science) Lib. QA and QC numbers most relevant
  - Edwards Library very small collection
- Online resources at [www.ku.edu/libraries](http://www.ku.edu/libraries)
  - selected journals
  - access to archived books and journals
  - interlibrary loan

[http://www.ittc.ku.edu/~jpgs/courses/source-cite.html](http://www.ittc.ku.edu/~jpgs/courses/source-cite.html)
Course Information

Sources of Literature: Web

- The Web
  - source for journal papers
    - ACM Digital Library, IEEE (subscription through library)
    - individual and project Web pages
  - source for information on research projects
  - source for other information
    - wikipedia: incredibly useful as launching point to other work
      - rarely appropriate to cite wikipedia pages
    - non-refereed reports and information
  - compare to a street corner bulletin board: use with care
  - use Web citations very judiciously
    - reports with many URL refs will not get an acceptable grade!

Class Participation

- 10% of grade is based on class participation
  - insightful questions and comments on lectures
  - evidence that reading has been done before lecture
  - brownie points
    - find bug in lecture note or book; make a good suggestion
    - email reminder with exact Subject: EECS780 - brownie point

- Interactive class is better for all of us
  - questions, comments, arguments
  - blurt it out; don't wait: you don't need to raise your hand
  - this may be a cultural shift for some of you; get used to it

- Reminder: reading before class essential
Course Information

Etiquette

• Try to be on time
  – I understand that we are all commuting, but...
  – consistent late arrivals are disruptive
• Inform me in advance if you need to miss class
  – we accommodate working professionals
  – we’ll arrange to make up missed material
• No audible mobile phone or pagers
  – if it doesn’t vibrate, turn it off!
• University does not tolerate class disruption
  – protests, sit-ins, heckling, etc. (I guess)
Academic Integrity and Plagiarism
Reading the Riot Act

• Apologies to those that already know this
  – … especially who’ve heard it from me before
• Opportunity to learn for those who:
  – are inexperienced in writing
  – come from an environment or culture of tolerance
• Warning of the consequences
  – ignorance will not be an excuse
  – ask me if you have any question about this
• Applies to
  – copying homework and lab exercises
  – cheating on exams
  – plagiarism on term paper and presentation

Academic Integrity and Plagiarism
Referencing and Citations

• All sources must be properly referenced and cited
  – authors, “paper name”, journal, date, publisher, page-range
  – also URL if from obscure source (e.g. university tech reports)
  – see course Web page or for examples
  James P.G. Sterbenz, Rajesh Krishnan, et al.,
  “Survivable Mobile Wireless Networks: Issues, Challenges, and Research Directions”,
  Proceedings of the ACM Wireless Security Workshop (WISE) 2002 at MobiCom,
• Cite whenever
  – work is related or ideas are used
  – text is quoted or paraphrased
  – diagrams are reproduced or incorporated (even if redrawn)
Academic Integrity and Plagiarism

Proper Quoting and Paraphrasing

- Quoting text or paraphrasing
  - “quotation marks” for sentence or less
  - blockquote for multiple sentences
- Beware of read-then-write in two windows
  - never ever cut-and-paste
  - take intermediate notes from which you write

Academic Integrity and Plagiarism

Excessive Quoting and Paraphrasing

- Quoting is rarely needed
  - example: quoting or paraphrasing definition or principle
- Sequence of quotes doesn’t show understanding
  - not a shortcut to English writing skills
    - better to be in your own imperfect English
  - papers with excessive quotes will not receive decent grade
    - even if properly quoted
Academic Integrity and Plagiarism

Detection and Sanctions

- Plagiarism is remarkably easy for me to detect
  - inconsistent writing styles and language use
  - technical depth beyond the supposed author
  - inconsistent terminology
- Tools: Web makes both plagiarism & detection easier
  - Google on suspicious phrases
  - automated tools match and highlight with fuzzy searches
- Plagiarism will result in F for course
  - and possible further sanctions
  - it is highly unlikely that you will get away with it!
    - but students still try every semester; you have been warned

Academic Integrity Quiz

- Homework this week: read
  http://www.ittc.ku.edu/~jpgs/courses/academic-integrity.html
  http://www.ittc.ku.edu/~jpgs/courses/source-cite.html
- You must understand this material
  - ask me if you have any question
  - goal is for new students to learn
- Next week: academic integrity quiz
Communication Networks

AE.3 Course Outline

AE.1 Administrivia
AE.2 Ethics and academic integrity
AE.3 Course outline
  I. Upper layers
  II. Lower layers
  III. Special topics

EECS 780 Outline

I: Upper Layers

I: Upper layers
  HA: Network history and architecture
  AL: Application layer
  TL: Transport layer

II: Lower layers
III: Special topics
EECS 780 Outline

HA: Network History and Architecture

- Understanding of where we are and how we got here
  - essential to understand why things are as they are
  - historical development of each
  - structure and architecture
- PSTN: public switched telephone network
  - traditionally voice over wired infrastructure
  - evolving for wireless, mobility, and data
- Internet
  - has become the global information infrastructure
- Other networks: SCADA, military, etc.

EECS 780 Outline

AL: Application Layer

- Distributed applications are the reason for networks
  - structure and operation of applications
  - characteristics: delay, bandwidth, loss tolerance
  - utility curves based on latency
- Information access applications
  - file transfer, Web and HTTP, netnews, P2P file sharing, ...
- Telepresence applications
  - email, chat, conferencing
- Distributed computing and storage
  - remote login, P2P file swarming, NAS, SANs
EECS 780 Outline

TL: Transport Layer

- Transport layer provides end-to-end communication
  - to distributed applications
- End-to-end vs. hop-by-hop communication
  - the end-to-end arguments
- Transport functions and mechanisms
  - framing and multiplexing
  - transfer modes and state management
  - reliability and error control
  - transmission (flow and congestion) control
- Internet transport protocols
  - TCP and UDP

II: Lower Layers

I: Upper layers

II: Lower layers

- NL: Network layer
- NR: Network routing
- LL: Link layer and LANs
- PL: Physical layer

III: Special topics
EECS 780 Outline

**NL: Network Layer**

- Network provides infrastructure to create E2E paths
  - addressing to identify network components
  - routing to discover end-to-end paths
  - forwarding through switches and routers
  - signalling for network control
  - traffic management
- Signalling paradigms
  - connection-oriented vs. connectionless
- Switch and router design
- PSTN addressing
- Internet protocols: DNS, IP, ICMP, DHCP, NAT

**NR: Network Routing**

- Network provides infrastructure to create E2E paths
  - addressing
  - routing to discover end-to-end paths
  - forwarding, signalling, traffic management
- Routing algorithms
  - distance vector, link state, source routing, DHTs
- PSTN routing architecture and algorithms
- Internet routing architecture and protocols
  - EGP: BGP
  - IGP: RIP, IGRP, EIGRP, OSPF, IS-IS
- Multicast routing algorithms
EECS 780 Outline

LL: Link Layer and LANs

- Links provide the connection between components
  - framing and delineation
  - error control
- LANs (local area networks)
  - topologies: point-to-point, ring, shared medium
  - multiplexing and switching
  - Ethernet and SONET
- Link layer components
  - hubs and layer 2 switches
- Residential broadband
  - HFC and DSL

EECS 780 Outline

PL: Physical Layer

- Physical layer responsible for information transfer
  - bits in a wire as electrons and photons
  - signals and transmission
- Physical media
  - wire, fiber, free-space wireless
- Performance characteristics
  - delay, attenuation, frequency response
- Line coding
  - analog and digital
EECS 780 Outline

III: Special Topics

I: Upper layers
II: Lower layers
III: Special topics

MW: MAC, mobile, and wireless
MS: Multimedia applications and session control
TQ: Traffic management and QoS
IS: Information security
NM: Network management

MW: Medium access control (MAC)
  - arbitrates access to shared medium
  - needed for free-space wireless and other shared media

MAC algorithms
  - channel partitioning, random access, coördinated access

Wireless networks
  - 802.11, 802.16, 802.15, sensor networks

Mobile networks
  - mobile IP
  - MANETs: mobile ad hoc networks
  - mobile cellular telephony
EECS 780 Outline

**MS: Multimedia Applications & Session Control**

- Multimedia applications
  - applications that stream audio and video media
  - VoIP: voice over IP
- Session control
  - coordinates multiple end-to-end transport flows
  - SIP: session initiation protocol and H.323
- Multimedia transport
  - additional timing and synchronisation
  - RTSP: real-time streaming protocol for media control
  - RTP: real-time transport protocol

**TQ: Traffic Management and QoS**

- Applications desire a particular service
  - in an environment of constrained network resources
  - traffic management controls and manages these resources
- Traffic characteristics and service models
  - best effort vs. guaranteed service
  - basic queueing analysis: M/M/1 and Little’s theorem
  - congestion control and avoidance
  - packet scheduling disciplines
- QoS and Internet service models
  - IntServ+RSVP and DiffServ
  - SIP and RTP
EECS 780 Outline
IS: Information Security

- Security functions and mechanisms
  - confidentiality and encryption
  - key distribution and revocation
  - authentication
  - integrity, digests, and digital signatures
  - nonrepudiation
  - access control
- End system protection
  - firewalls, intrusion detection, anti-virus and -worm
- Resilience and survivability

EECS 780 Outline
NM: Network Management

- Understanding and controlling network operations
  - increasingly hard as networks become more complex
- Network management functions
  - monitoring and detection
  - network operation and engineering
- Internet management protocols
  - MIBs (management information bases)
  - SNMP (simple network management protocol)
EECS 780
Communication Networks

• And now, the course begins...