Networking & Communications

Prof. Ethan Katz-Bassett
Internet use continues to grow

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- One third of the world population uses Facebook
Internet use continues to grow

- Half the world population is online
- One third of the world population uses Facebook
- # of cell phone users exceeds # of toothbrush users
Internet traffic is exploding

- Unparalleled growth in devices, data rates, and traffic
- 1 billion hours of YouTube streamed every day
- Services evolving from high-speed data and video towards Augmented Reality, Virtual Reality and Internet of Things
Wireless and Wireline Networks

Cellular Networks
- LTE

Local Area Networks
- Small cells
- Wi-Fi a, g, n, ac, ...
- DAS

Body/Personal Area Networks
- ZigBee
- Bluetooth
- RFID

Range: Short < Long
Data Rate: Low < High
Wireless and Wireline Networks

- **Cellular Networks**
  - LTE Advanced
  - Het-nets
  - 5G
  - Wi-Fi a, g, n, ac, …

- **Local Area Networks**
  - DAS

- **Body/Personal Area Networks**
  - RFID

- **Internet of Things**
  - Short-range (Bluetooth)

- **Local Area Networks**
  - Short-range (Wi-Fi)

**Data Rate**
- Low < DATA RATE > High

**Range**
- Short < RANGE > Long
Wireless and Wireline Networks

- Data center networks, cloud computing
- Optical networks
- Content distribution networks

Cellular Networks
- LTE Advanced
- 5G
- Het-nets
- DSL
- WiMAX
- Wi-Fi
- BlueTooth
- RFID
- DAS
- Multimedia Access Networks
- Small cells
- Wi-Fi a, g, n, ac, …

Local Area Networks
- 802.11a, b, g, n, ac, …
- Wi-Fi
- Ethernet
- DSL
- Coaxial cable

Body/Personal Area Networks
- ZigBee
- Bodynets
- Personal area networks

Internet of Things
- IoT
- M2M
- Edge
- Access/Aggregation
- Core

Short < Range > Long

Low < Data Rate > High
Networks - Challenges

- Available anytime and anywhere, from any device
- Incorporate **new technologies**, support/enable **new classes of applications** and services, and meet new requirements
- **Scale** and adapt to types of applications, topology, mobility patterns, and heterogeneity of devices
- Easily controllable and **manageable**
- Resource and energy **efficient**
- Secure and robust to failures and attacks
Enabled by: Networking and Communications
Recent topics for ELEN E6713, ELEN E677*, & other related topics courses:

- ELEN E4902 Topic: IoT - Intelligent Connected Sys. (Fall '15)
- ELEN E6713 Topic: Wireless Sensing (Fall '12, '10)
- ELEN E6713 Topic: Cooperative Wireless Communication Sys (Fall '13)
- ELEN E6713 Topic: Modern Digital Modulation Techniques (Spring '17)
- ELEN E6733 Topic: mmWave & Applications for 5G (Fall '16, '17)
- ELEN E6770 Topic: Next Generation Networks (Fall '18, '17, '16)
- ELEN E6770 Topic: Network Virtualization & Cloud Computing (Fall '19)
- ELEN E6771 Topic: Next Generation IP Networks (Fall '08)
- ELEN E6771 Topic: 5G Programmable Networks (Spring '19)
- ELEN E6772 Topic: Resilient Networking (Spring '19 '20)
- ELEN E6773 Topic: Network Econ & Engineering (Fall '14, Spring '14)
- ELEN E6774 Topic: Cyber-Physical Systems, Transportation (Spring '09)
- ELEN E4902 Topic: Seminar on Internet Measurements (Fall '19)
- ELEN E6713 Topic: Wireless Sensing (Fall '12, '10)
- ELEN E6713 Topic: Cooperative Wireless Communication Sys (Fall '13)
- ELEN E6713 Topic: Modern Digital Modulation Techniques (Spring '17)
- ELEN E6733 Topic: mmWave & Applications for 5G (Fall '16, '17)
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- ELEN E6774 Topic: Cyber-Physical Systems, Transportation (Spring '09)
ELEN E6774 Topic: Internet Measurement (Fall ’19)
ELEN E6770 Topic: Network Virtualization & Cloud Computing (Fall '19, ’08-'18)
ELEN E6776 Topic: Content Storage & Distribution (Fall '19, ’18, 09-'18)
ELEN E6774 Topic: Internet Measurement (Fall '19)
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Communications

ELEN E6713 Topic: mmWave & Applications for 5G (Fall '19, '17)

Legend

✓ offered Fall '19

Bold border= offered regularly

Green= senior/grad

Orange= advanced grad

Dotted= EE related area
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Communications

ELEN E5410
Solar Energy
& Smart Grid

ELEN E4510
Solar Energy
& Smart Grid

EECS E4750
Het. Comp.
SP, Data Proc.

PROG

ELEN E4702
Digital
Comm.

ELEN E4815
Random Sig.
& Noise

OR

ELEN E6712
Comm.
Theory

OR

ELEN E6713
Topics in
Comm

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Additional Classes

• Networking (CS)
  - COMS 6998 Topics: Datacenter Networking
  - COMS 6998 Topics: Cloud Computing & Big Data

• Related
  - COMS 3420 Privacy in a Networked World
  - COMS 4113 Fundamentals of Large-scale Distributed Systems
  - COMS 4995 Topics: Introduction to Devops
  - COMS 4995 Topics: Blockchains and Applications
  - COMS 6185 Intrusion Detection Systems
  - COMS 6998 Topics: Analysis of Networks and Crowds

• Analytical Tools (CS, IEOR)
  - CSOR 4231 (4246) Analysis of Algorithms (Algorithms for Data Science)
  - IEOR - Stochastic models, Optimization, etc.
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General Advice

• It’s a short program – plan ahead
• Don’t repeat undergraduate classes…
• Sample several classes
• Consider classes beyond the EE dept.
  – e.g., Networking classes – in EE and CS
• Participate in a research project/s (spring or summer)
• Look for a summer internship (winter)