National Tsing Hua University, Hsinchu, Taiwan

CS 5263: Wireless Multimedia Networking Technologies and Applications

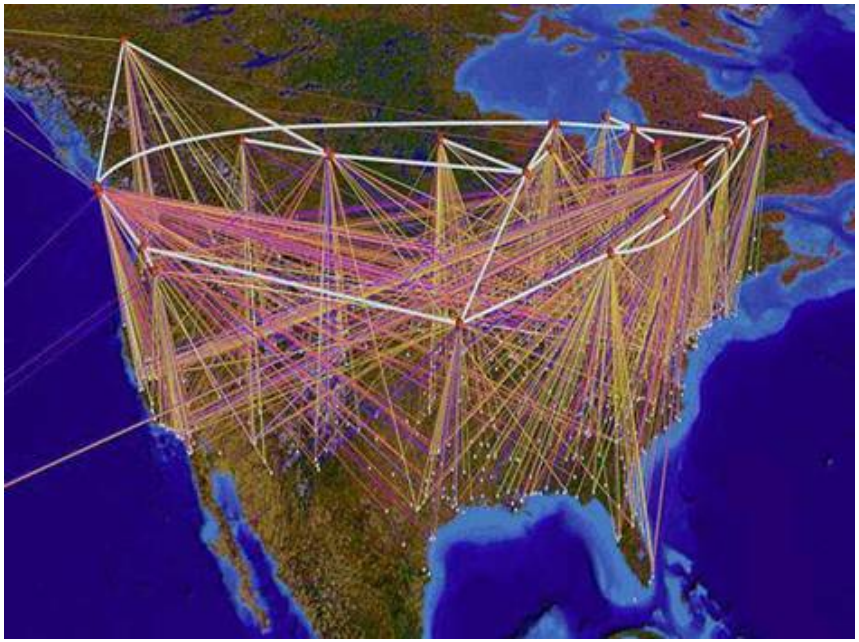
Introduction

Instructor: Cheng-Hsin Hsu

Acknowledgement: The instructor thanks Prof. Mohamed Hefeeda at Simon Fraser University, Prof. Roger Zimmermann at National University of Singapore for sharing their course materials

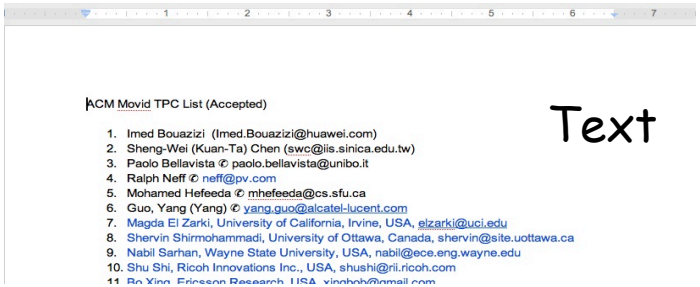
What is Networking?

- Multiple computers connected by communication channels for
  - Information sharing: WWW, Facebook, and BitTorrent
  - Resource sharing: X-Window and Cloud Computing

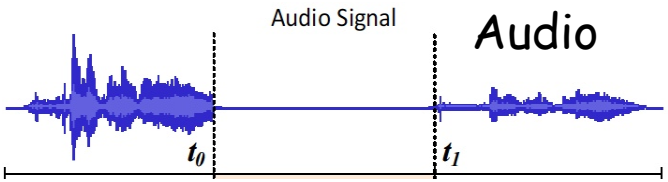


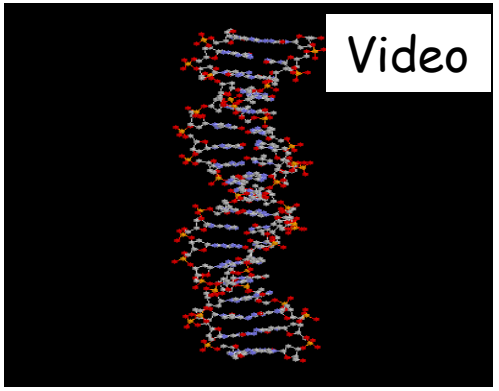
What is Multimedia?

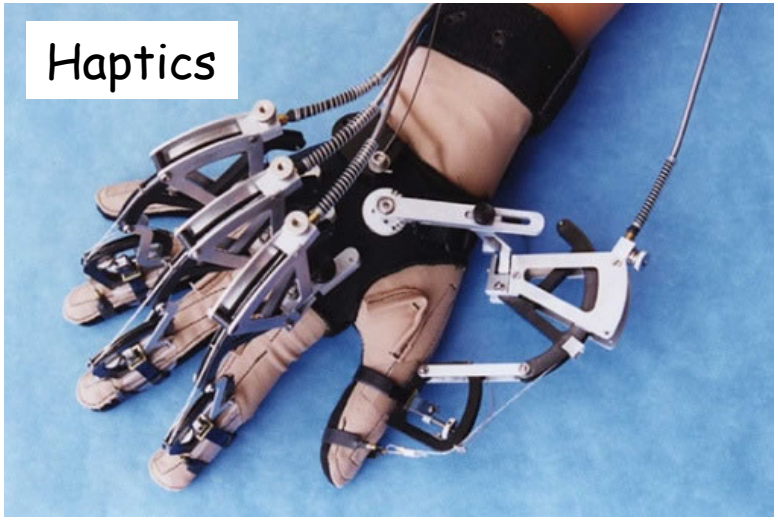
- Media, or content, in various forms, including



Text

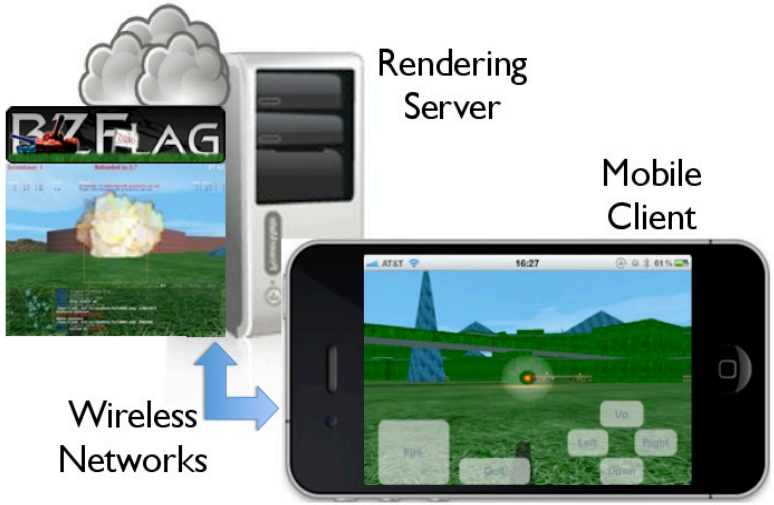






What is Multimedia Networks, Then?

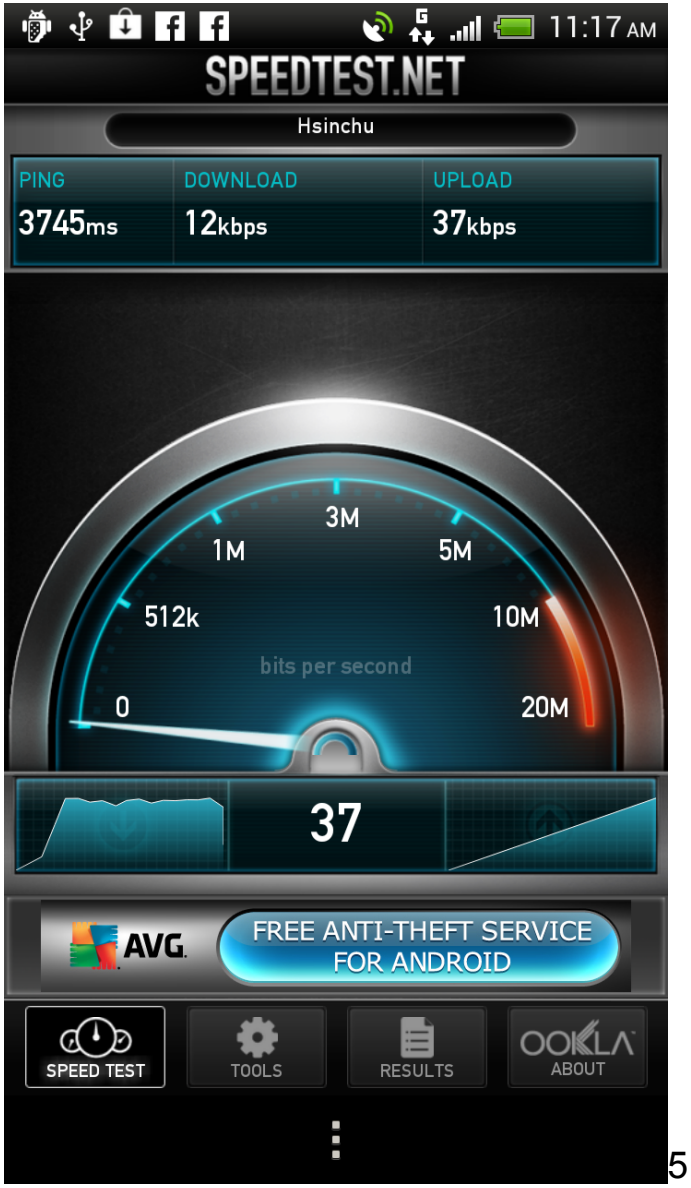
- Distributed multimedia applications
  - Versus local multimedia applications, such as BlueRay
  - Examples: video streaming, video conferencing, mobile TV, rich-content emails



Mobile Cloud Games

Challenges

- Multimedia contents are
  - Large: Batman video consists of 820 frames in 720p (1280x720) resolution. It plays in 16.4 s, but has a staggering size of 1.1 GB. Took my NTHU network 130 s to download!
  - Real-time requirements: for continuous playouts!
- The current Internet is
  - Bandwidth limited
  - Best-of-effort: packets may be late, lost, and corrupted



Challenges (cont.)

- Networked multimedia applications have stringent requirements on
  - Delay: real-time
  - Quality: user experience, related to: (i) video quality, (ii) playout continuity, (iii) synchronization, and (iv) loss robustness, to name a few
- Conflicts (or tradeoffs) between
  - Content size and network bandwidth
  - Real-time requirements and best-effort networks
- Heterogeneous devices and networks ← How to make everyone happy?

Many research problems and industrial applications

About the Course

- Time: Mondays 3:30-5:20 p.m., Thursdays 2:20-3:10 p.m.
- Location: EECS 129
- TAs:
  - Ying-Yi Chen (inin610719@gmail.com)
  - Chih-Pin Tan (tanchihpin0517@gmail.com)
- Format:
  - The lectures (excluding guest speakers) will be given in English
  - All written reports, assignments, and slides must be in English
  - Students are encouraged to give oral presentations in English
  - In-class discussion, questions, and comments can be in Mandarin
- Course Website, please read carefully:

  http://nmsl.cs.nthu.edu.tw/index.php/courses

Course Objectives

- Open-ended
  - You are free to work on any aspects in multimedia and/or networking
- Understand fundamentals of networked multimedia systems
- Get familiar with Android programming (and how to publish your apps)
- Know current research issues in multimedia systems
- Develop research skills through hands-on actitivies (term projects)
- Have fun!

Tentative Scope (1/2)

- 35% lectures on networking and image/video background
  - Overview on Computer Network
  - Wireless networks
  - Multimedia networking (WebRTC)
  - Digital Image and Color Models
  - Overview on Video Coding
  - Scalable Video Coding (H.265 SHVC)
  - Video Quality Metrics

Tentative Scope (2/2)

- 35% lectures on advanced topics through paper reading and term projects on Mondays
  - Each student will pick a direction/research project
  - Presentations will be given by students
- 10% Talks from entrepreneurs on Mondays
  - Mobile computing
  - Head-Mounted Displays
  - Virtual reality content
  - Wireless video streaming
  - …… (please suggest more topics that interest you)
- 20% Android tutorials on Thursdays

Android Tutorials

- Tentative topics
  1. Environment setup: My First Android Project
  2. Basic User Interface: Activity and Action Bar
  3. Advanced User Interface: Fragment and Layout
  4. Multithreading: Handler and Asynctask
  5. Data Management: Content Provider and Database
  6. Networking: WiFi and Bluetooth
  7. Multimedia: Exo Player and Camera
  8. Integration: Facebook API
  9. (4 more topics will be identified)
- Each tutorial lasts for 60 mins with in-class exercise problems
- You need to bring your own laptop for the tutorials

Tentative Programming Projects

- DASH video streaming to Android devices
  - Building a complete DASH streaming system with clients running on Android phones
- RTP streaming of heterogeneous data types
  - Streaming 3D meshes, sensory data, or others using RTP protocol to Android phones
- Software-based H.265 video codecs
  - Adding new (innovative) features to an open-source H.265 codec

Textbooks References

- References
  - **[KR12]** Kurose and Rose, **Computer Networking: A top-down Approach Featuring the Internet**, Addison Wesley, 2012
  - **[Burg09]** Burg, **The Science of Digital Media**, Prentice Hall, 2009
  - **[SC07]** Schaar and Chou (editors), **Multimedia over IP and Wireless Networks: Compression, Networking, and Systems**, Elsevier, 2007 ← **ecopy available at the library**
  - **[WOZ02] Wang, Ostermann, Zhang, Video Processing and Communications, Prentice Hall, 2002**
  - **Research papers found at IEEE Xplore, ACM Digital Library, and Google Scholar**

Grading

- No homework nor exam
- Course participation: 20%
  - To encourage you asking/answering question, each question asked/answered in the lecture leads to 0.5 point toward the final grade.
  - Each day, each student, can receive up to 1 participation point
- Programming Projects: 30%
  - Three programming projects

Grading (cont.)

- Term Project: 50%
  - Graduate students: Produce a workshop paper by end of the semester
  - Undergraduate students: Build an Andorid app (and a demo paper) by end of the semester
- Break-down of Term Projects:
  - Paper/progress presentations (10%)
  - Proposal (10%)
  - Final report, i.e., your workshop/demo paper (25%)
  - Poster/Demo (5%)

Sample Term Projects

- 3D game streaming system for stereoscopic videos
- Microdrone video streaming system for senior/pet safety
- WebRTC based mobile streaming for Quality-of-Experience study
- 2D/3D mesh streaming for distributed rendering
- Video analytics using Spark Streaming for IoT and smartcity applications
- 360-degree video streaming to Head-Mounted Displays
- Ultra-low-bitrate video conferencing
- Multimedia fog computing systems

Time Allocation

- Mondays
  - 1-hour lecture
  - 1-hour student presentation
    - Graduate students: paper presentation
    - Undergraduate students: Android project proposal and progress update
  - 2-hour invited talks
- Thursdays
  - 1-hour lecture
  - 1-hour Android tutorial

- Detailed schedule will be posted online soon….

Questions?

chsu@cs.nthu.edu.tw