# Group Project

**Report & Video due April 14 (11:59pm)**

Choose *one* of the topics on the following pages or (**preferably!!**) propose your own project. The project involves reading and summarizing 4-6 papers on a topic (both in a presentation and a report). If you wish, you can include some simple experimentation – network measurements, for example.

Feel free to propose any project that you consider falls in the field of telecommunication networks or signal processing. I am available to discuss any ideas you have. If you wish to propose a project I highly recommend discussing your idea with me to ensure that the topic is well-matched to the course material and that it is of appropriate difficulty.

Projects will be conducted in groups of four.

## 1. Deliverables and Evaluation

1. Submit a very brief description of the project you will undertake on myCourses by midnight on March 17 (5% of the total marks for this project)
2. 10-minute video by April 9. (40% of the total marks)
3. Project report due on April 9. (55% of the total marks)
4. Grades and comments for 4 other videos due April 16 (5% of the total marks)

## 2. Project Description

Submit a brief project description via myCourses. The document should be one or two paragraphs long (200-300 words) and provide a very short summary of the topic you want to research. Ideally, you should cite a paper or two you plan to start with.

## 3. Video

You are required to prepare a video, no longer than 10 minutes. It's fine for this to be a set of slides with you talking about them.
When preparing your video, take into account the following suggestions, based on presentations and videos from previous semesters. Do not have too much text on your slides. Good illustrations accompanied by well-prepared verbal explanation work best. Think about it this way: you will try to explain what you have found out about your topic to your colleagues in an "audience-friendly" way. Answer the following questions: What application/phenomenon did you look at? Why is this relevant and fascinating? What were your key insights/observations/conclusions?

## 4. Report

Submit a soft copy of your report in PDF format via myCourses by midnight on Apr.9.

**Format:** Organize and format your report in a logical and professional manner. Remember, your thoughts and ideas are important, and deserve to be presented in a way that reflects this. The report should include references and (possibly) figures. References listed at the end of your report *must* also be mentioned (i.e., cited) in the text!! Including references or figures without referring to them in the text of your report is a common mistake, and it will be penalized. If you include a reference

in your bibliography, you must cite it in your report to put it in context. Likewise, any figure included in the report must be labeled (e.g., Figure 1), must have a descriptive caption, and must be referred to in the body of your report to put it in context. Make sure the caption contains sufficient text so that a knowledgeable reader can read only the caption and understand what point or points are to be concluded or learned from the figure.

Reports must be written in complete, grammatically correct sentences, and the writing must be clear and concise. Numbered or bulleted lists should be avoided.

I expect *at least 4* authoritative references in your final report. Wikipedia, although a useful source of information, is *not* authoritative. Websites, in general, will not count as authoritative. Of course, you are welcome to include as many references as you find relevant to your project, and 4 is not the maximum. Also, although the course textbooks are useful starting points, these will not count towards your 4 references. You must make use of other resources.

For the various types of documents that you cite, the reference given in your paper must include (for documents other than the types listed here, clarify with me what you should supply):

- *Conference paper:* author, title, conference title, location, date (month and year);
- *Journal paper:* author, title, journal title, volume, issue number, year, page numbers;
- *Book:* author(s) or editor(s), title, publisher, publisher's address, year;
- *Webpage:* (Only use these if there is *no* corresponding article) title, author, http address, date accessed. The URL alone is not sufficient!

See the document https://www.ieee.org/documents/style_manual.pdf (starting from page 36 of the pdf) for detailed instructions on how to format references.

If you have any questions about formatting, presentation, or proper citations, please do not hesitate to ask. Post a question on myCourses because the answer (and your question) will most likely be helpful to others in the class as well.

*DO NOT PLAGIARISE (EVEN UNINTENTIONALLY)* – if you use someone else's work, cite it. If you reproduce figures from other documents, then you must write in the caption "Reproduced from [1]" where [1] is listed in the references (and may change to [3], [8], etc.).

**Page Length:** The project report should be 5 pages long, formatted according to the instructions here: https://2020.ieeeicassp.org/authors/paper-kit/ (5th page should just be references). There are latex and word templates available.

## 5. Project Suggestions

The following pages outline a number of potential project topics. These are only suggestions to give you an idea of the type of project that you could do. They do not have to be followed precisely. I'd much prefer that you propose your own topic or significantly adapt one of these projects to suit your own interests or experience. It's not so interesting when multiple students in the class survey the same topic. I am also available to discuss your project ideas. If you have your own idea for a project you would like to pursue, please check with me before proceeding in order to make sure your idea is of the right scope and complexity for this course.

## *Potential Topics*

NETWORKS

**Routing in Anonymous Communication**

Onion routing is a technique for communicating anonymously over a computer network. Messages are encrypted, and they are redirected through intermediate nodes in order to hide the original sender of the message. At the same time, the system is designed in order to allow bi-directional communication (someone can send a request to a server, and the server can send them a response over the anonymous network). Tor is one example of a system implementing anonymous networking today.
A starting point is: F. Shirazi et al., "A Survey on Routing in Anonymous Communication Protocols", *ACM Computing Surveys*, vol. 51, no. 3, June 2018, pp. 51:1:39.

**In-Vehicle Networks**

Networks are used inside vehicles to share control information between different controller units. Investigate the main challenges involved in the design and operation of these networks.

Starting paper: W. Zeng et al., "In-Vehicle Networks Outlook: Achievements and Challenges," *IEEE Comm. Surveys & Tutorials*, vol. 18, no. 3, Sept. 2016, pp. 1552 – 1571.

**Internet Exchange Points**

Examine the role of Internet exchange points in today's Internet. Discuss whether these form a significant vulnerability.

Starting paper: N. Chatzis et al. "There is More to IXPs than Meets the Eye", *ACM SIGCOMM Computer Communication Review*, vol. 43, no. 5, Oct. 2013, pp. 19-28.

**Adaptive Bitrate Algorithms**

Most Internet video delivery employs adaptive bitrate (ABR) algorithms. Discuss the strengths and weaknesses of existing approaches.

Starting paper: Z. Akhtar et al., "Oboe: Auto-tuning Video ABR Algorithms to Network Conditions," in Proc. ACM SIGCOMM, Budapest, Hungary, Aug. 2018.

**In-body Backscatter Communication**

Backscatter systems have been proposed as a possible way to localize and communicate with micro-implants in the human body. Review such systems, discussing the challenges that must be overcome for successful practical deployment.

Starting paper: D. Vasisht et al., "In-body backscatter communication and localization," in Proc. ACM SIGCOMM, Budapest, Hungary, Aug. 2018.

**Traffic optimization in data centres**

Reinforcement learning has recently been proposed as a possible approach for performing traffic optimization in data centres. Discuss the strengths and weaknesses of such an approach, and compare to traditional methods.

Starting paper: L. Chen et al. "AuTO: scaling deep reinforcement learning for datacenter-scale automatic traffic optimization," in Proc. ACM SIGCOMM, Budapest, Hungary, Aug. 2018.

**Serving Infrastructures of Content Distribution Networks**

Large content providers need to pay much attention to the design and implementation of their serving infrastructures. The infrastructures consist of server clusters and connectivity fabric. Building on the paper below, which describes Akamai's serving infrastructure, and the papers it cites, e.g. [42, 47] in the paper, discuss the nature of the serving infrastructure of large CDNs and the issues that must be addressed during design of the infrastructure.

Starting paper: F. Wohlfart et al., "Leveraging interconnections for performance: the serving infrastructure of a large CDN ," in Proc. ACM SIGCOMM, Budapest, Hungary, Aug. 2018.

**Low Power Wide Area Wireless Networks**

Discuss the possible uses and challenges in implementing low-power wide area wireless networks in urban environments. Survey recent approaches towards overcoming these challenges.

Starting paper: R. Eletreby et al., "Empowering Low-Power Wide Area Networks in Urban Settings," in Proc. ACM SIGCOMM, Los Angeles, USA, Aug. 2017.

**Internet Reliability: Router Outages and Reachability**

Discuss the robustness and resilience of the network from the perspective of router outages and reachability problems Explain why it can be difficult to assess the resilience through measurements.

Starting paper: M. Luckie and R. Beverly, "The Impact of Router Outages on the AS-level Internet," in Proc. ACM SIGCOMM, Los Angeles, USA, Aug. 2017.

SIGNALS

**Time-frequency Analysis of EEG Signals**

Discuss how time-frequency analysis can be used to analyze EEG signals.
Complete the tutorial here: http://www.fieldtriptoolbox.org/workshop/oslo2019/timefrequency/
Investigate how the taper (window) affects performance. Propose and implement a method to set the window automatically to a good value.

Starting paper: B.J. Roach and D.H. Mathalon, "Event-related EEG time-frequency analysis: an overview of measures and an analysis of early gamma band phase locking in schizophrenia," *Schizophrenia Bulletin,* vol. 34, no. 5, pp.907 – 926, 2008.

**Financial Signal Analysis**

Examine whether Fourier analysis can be used to predict future stock prices. Repeat the approach in the starting paper. I can provide data if required.

Starting paper: B. Stádník, J. Raudeliuniene, and V. Davidavičienė, "Fourier Analysis for Stock Price Forecasting: Assumption and Evidence," Journal of Business Economics and Management, vol. 17, pp. 365-380, 2016.

**Analysis of Microwave Breast Cancer Detection Signals**

[This project is more challenging and goes beyond the course material. Consider this carefully before choosing it. You could alternatively analyze the frequency content of the breast cancer signals].
Beamforming algorithms are commonly used to generate images from data collected by microwave radar based breast cancer detector systems. Provide an overview of the different algorithms. Implement the DMAS algorithm from the starting paper and analyze the datasets. Propose an improvement that can lead to better images. I can provide data for you to analyze.

Starting paper: H. B. Lim, N. T. T. Nhung, E.-P. Li, and N. D. Thang, "Confocal microwave imaging for breast cancer detection: Delay-multiply-and-sum image reconstruction algorithm," *IEEE Transactions on Biomedical Engineering*, vol. 55, no. 6, pp. 1697–1704, 2008.

**Analysis of Speech Signals**

Explain how the Mel Frequency Cepstral Coefficients are calculated after application of the Fourier transform to a speech signal. Explain the role of the window function. Summarize why a multitaper approach may improve robustness.

The tutorial here should help: https://wiki.aalto.fi/display/ITSP/Cepstrum+and+MFCC

Starting paper: T. Kinnunen, R. Saeidi, J. Sandberg, and M. Hansson-Sandsten, "What else is new than the Hamming window? Robust MFCCs for speaker recognition via multitapering," in *Proc. Ann. Conf. Int. Speech Comm. Assoc.,* Makuhari, Japan, Sept. 2010.

[Extension: Complete the tensorflow audio recognition tutorial at:
https://github.com/tensorflow/docs/blob/master/site/en/r1/tutorials/sequences/audio_recognition.md

Compare the performance of the audio recognition tool when you use MFCCs versus spectrograms as inputs.]