Cooperative Communications and Networking

Instructor: Kuang-Hao Liu, 🏠 Delta Hall Room 907, ☎ 42589, ✉ khliu@ee.nthu.edu.tw
Lectures: Tuesday 10:10am - 12:00pm, Thursday 11:00am - 12:00pm Delta Building Room 210
Office Hour: 4:00pm-5:00pm, Wednesday
Office Hour: Hosted on Elearn
Suggested Prerequisite: Probabilities and Random Processes, Digital Communications
Grading Policy: midterm=20%, project=40%, assignments=40%

Course Materials:
Handouts prepared by the instructor. Available to download for enrolled students.

References:
1. A. Glodsmith, Wireless Communications, Cambridge University Press, 2005, ISBN: 978-0521837163.

2. Y.-W. Hong, W.-J. Huang, C.-C. Kuo, *Cooperative Communications and Networking: Technologies and System Design*, Springer, 2010, ISBN: 978-1441971944 (available in the university library).

Overview:

合作式通訊是眾多無線通訊技術中的一個分支，其概念是利用無線電波的“廣播”特性，讓分散在不同位置的天線互相協助，而不將彼此的訊號視為“干擾”，可視為多天線技術的特例，除了 5G 標準已為合作式通訊量身訂做對應規格，對低功率的物聯網也十分有用。本課程將深入淺出的介紹合作式通訊技術，首先由無線傳輸的特性談起，說明合作式通訊的起源，並介紹課程中常用到的相關基礎，接著正式講述合作式通訊技術，包含涵蓋手持裝置間與基地台間的合作，以及針對新興物聯網的合作式通訊情境，最後介紹一些合作式通訊的有趣延伸。本課程適合研究領域與無線通訊相關的研究生，或是修習過通訊基礎課程對無線通訊有興趣的大學部學生。學期中會有 3∼4 次作業，一次期中考，期末則有小專題。

While most of the end users are eager to try new smart phone products, a new era of wireless communications has just arrived that fundamentally changes the way that a device communicates to the distant base station. Among numerous upcoming technology breakthroughts, this course will focus on the so-called “cooperative communications” and its applications in sensor and cellular networks.

Expected audiences are graduate students who know the basics of digital communications and will pursue their graduate studies in the area of wireless communications. Although the course has a specific focus on cooperative communications, it will cover the basic principles of wireless communications and thus it is particularly suitable to fresh graduate students. Besides theoretical development, this course is featured by delivering computer simulation skills required for studying wireless communication systems that will benefit graduate students in terms of their research work and thesis preparation.

With the foundations established in the first few weeks, the course will move on to introduce existing cooperative protocols, which serve as the key enabler for cooperation among wireless nodes. To assess the pros and cons of different cooperative protocols, methods for analyzing the performance of cooperative networks will be addressed. By developing both closed-form and asymptotic expressions for various performance metrics, students can get more insights into cooperative communications. Meanwhile, simulation framework built in the first part of this course will be reused and extended to validate the analysis accuracy and also to facilitate performance evaluation.

Finally, some important applications of cooperative communications will be discussed. Tentative

topics include packet-level cooperation (a.k.a. network coding), cooperation between base stations, cooperative message dissemination in vehicular networks, and cooperative spectrum sensing. By discussing the related applications, students may find potential extensions of cooperative communications as their own research.

Lectures will be based on the handouts and slides. Active class participation is mandatory. In-class time will be divided between lectures, student presentations, and group discussions. The course grade will be based on class presentation and participation, three or four homework assignments, and a final project (details will be given in the first lecture).

Course Outline (**Eight chapters in 16 weeks**)

Ch01 Introduction

Ch02 Characterization of Wireless Channels

Ch03 Diversity Techniques for Fading Channels

Ch04 Cooperative Communications with Single Relay

Ch05 Cooperative Communications with Multiple Relays

Ch06 Cooperative Communications with Multiple Sources

Ch07 Distributed Cooperative Networks

Ch08 Selected Applications (IoT, 5G, Energy Harvesting, etc.)