ECE 6604 – Example Project Topics

I- Guidelines

All guidelines were posted in Lecture 1 and the Syllabus. Final deadline for selecting a project and getting it approved is **September 16th**. Note that there are many good conferences that can contain suitable topics such as IEEE INFOCOM, IEEE ICC, IEEE GLOBECOM, ACM MobiHoc, ACM MobiCom, IEEE MILCOM, etc.

II- Example Research Topics

You are encouraged to choose a topic that is aligned with your research aspirations and interests. For example, the project could be relevant to the students' master's/PhD thesis. The students are encouraged to find their own topics as well. You **are responsible to find the appropriate papers; the ones provided below are just examples.**

Hereinafter, I provide a list of potential topics. Note that, this list is only provided as a **suggestion** and the students can pick their own topic as long as I approve it:

- Collaboration in Wikipedia, example paper:
  - S. Anand, O. Arazy, N. B. Mandayam and O. Nov, "A Game Theoretic Analysis of Collaboration in Wikipedia", in Proceedings GameSec 2013 (this was paper review 1). Possible extensions include discussing more realistic utility functions or incorporating possibility of cheating (via bounded rationality concepts for example.
- Transportation systems and game theory
  - Truck platooning, example paper: Farhad Farokhi and Karl H. Johansson, "A Game-Theoretic Framework for Studying Truck Platooning Incentives", Proceedings of the 16th International IEEE Annual Conference on Intelligent Transportation Systems (ITSC 2013), The Hague, The Netherlands, October 6-9, 2013.
  - Traffic control in highways, example paper: Christian Portilla, Felipe Valencia, Jose David Lopez, Jairo Espinosa, Alfredo Nunez, Bart De Schutter, "Non-Linear Model Predictive Control Based on Game Theory for Traffic Control on Highways", 4th IFAC Nonlinear Model Predictive Control Conference
- Energy efficiency in heterogeneous wireless networks, Example papers:
  - Y. S. Soh, T. Q. Quek, M. Kontouris, and H. Shin, "Energy Efficient Heterogeneous Cellular Networks", IEEE Journal on Selected Areas in Communications (JSAC), May 2013 (this paper looks at optimization, can be extended to a game)
  - E. Yaacoub, A. Imran, Z. Dawy, and A. Abu-Dayya, "A game theoretic framework for energy efficient deployment and operation of heterogeneous LTE

networks", IEEE CAMAD 2013 (this paper considers cooperative games between base stations, it can be extended to take into account additional backhaul constraints when base stations are cooperating).

- In general, there are a bunch of papers looking at "sleep modes" in wireless systems that can be modeled as a game.

- Applications of network formation games in wireless or social networks. Example papers:
  - http://www2.warwick.ac.uk/fac/soc/economics/news_events/conferences/ctn/baetz.pdf
  - http://arxiv.org/pdf/1204.1160v1.pdf (this paper does not use game theory, but it would of interest to extend to a game-theoretic setting)
  - W. Saad, Z. Han, T. Başar, M. Debbah, and A. Hjørungnes, "Network Formation Games Among Relay Stations in Next Generation Wireless Networks," IEEE Transactions on Communications, vol. 59, no. 9, pp. 2528-2542, September 2011.
  - W. Saad, Q. Zhu, T. Başar, Z. Han and A. Hjørungnes, "Hierarchical Network Formation Games in the Uplink of Multi-hop Wireless Networks," in Proc. of the IEEE Global Communications Conference (GLOBECOM), Wireless Networking Symposium, Hawaii, USA, December 2009.
  - http://arxiv.org/pdf/1310.0720v3.pdf , this paper surveys D2D in wireless system, D2D can be used to define a network formation game. For example, you can extend the paper above (Saad, Han, et al.) to a D2D setting.
- Game theory in the smart grid, example papers:
  - W. Saad, Z. Han, H. V. Poor, and T. Başar, "Game Theoretic Methods for the Smart Grid," IEEE Signal Processing Magazine, Special issue on Signal Processing for the Smart Grid, vol. 29, no. 5, pp. 86-105, September 2012 (this survey presents several directions that may be used to define a project in this course)
  - http://www.dtic.mil/dtic/tr/fulltext/u2/a557336.pdf (nice thesis with some possible topics on smart grid security with games).
  - H. K. Nguyen, J. B. Song, and Z. Han, "Demand side management to reduce Peak-to-Average Ratio using game theory in smart grid", IEEE INFOCOM 2012 Workshop on CCSES.
- Cyberphysical security, example papers:
  - Extending the paper reviewed in the second week "A Game Theoretic Study of Attack and Defense in Cyber-Physical Systems" by investigating more realistic utility models and other advanced games.
  - http://arxiv.org/pdf/1304.3996v1.pdf => good survey with many potential problems to be tackled
  - S. Liu, X. Feng, D. Kundur, T. Zourntos, and K. L. Butler-Purry, "Switched system models for coordinated cyber-physical attack construction and

simulation”, IEEE SGMS 2011. This paper does not look at a game, so one approach is to extend it into a game setting.

- Applications of contract theory in wireless systems, example papers:
  - http://arxiv.org/pdf/1207.6667v4.pdf
  - L. Duan and J. Huang, “Cooperative Spectrum Sharing: A Contract-Based Approach”, IEEE Transactions on Mobile Computing, January 2014.
- Game theory for moving target defense, example papers:
  - Q. Zhu and T. Basar, “Game-Theoretic Approach to Feedback-Driven Multi-stage Moving Target Defense”, GameSec 2013.
  - P. K. Manadhata ,“Game Theoretic Approaches to Attack Surface Shifting”, Advances in Information Security Volume 100, 2013.
  - V. Casola, A. De Benedictis, and M. Albanese, “A moving target defense approach for protecting resource-constrained distributed devices”, IEEE IRI 2013. This is not a game but can be extended to a game setting.
- Applications of cops and robbers games, example papers (the below papers can be extended to a wireless or social network):
  - http://www.macalester.edu/~abeverid/papers/geocops.pdf
  - http://www.ii.uib.no/~daniello/papers/CopRobberFuel.pdf

- Applications of location games, example papers:
  - http://arxiv.org/pdf/0911.0257v2.pdf
  - F. Pan, R. Bent, A. Brescheid, and D. Izraelevitz , “Locating PHEV Exchange Stations in V2G”, IEEE SmartGridComm 2010.

III- Example Implementation Topics

If a group of students is more interested in doing some form of software implementation, instead of a research topic, this group is allowed to do so, provided the project has sufficient depth and scope to span the entire semester. Here, I provide some examples of such topics:

1. Implement the mobile tethering game

The mobile tethering game has been presented in:

http://www.es.ewi.tudelft.nl/msc-theses/2012-Constantinescu.pdf

with possible implementation over Android phones. Replicate and improve upon this implementation in the course of this class.

2. Visualizing the Merge-and-Split Algorithm for Coalition Formation

The merge-and-split algorithm has been a popular approach to solving coalition formation games

(see W. Saad, Z. Han,Debbah, A. Hjørungnes, and T. Basar, "Coalitional Game Theory for Communication Networks: A Tutorial," IEEE Signal Processing Magazine, Special Issue on Game Theory, vol. 26, no. 5, pp. 77-97, September 2009.). In this project, your goal is to implement a Graphical User Interface (GUI) that allows users to insert values of coalitions and then run/visualize how coalitions merge/split.

3. Game Theory for Education

Suggest a game-theoretic model that can be adopted in class for enhancing learning in a course. Alternatively, suggest a game-theoretic model to assess how students and teachers interact (see this paper:
http://ieeexplore.ieee.org/xpl/login.jsp?tp=&arnumber=6142933&url=http%3A%2F%2Fieeexplore.ieee.org%2Fxpls%2Fabs_all.jsp%3Farnumber%3D6142933
as an example)

4. Matching Base Stations or Jobs in the Cloud

One key problem in wireless networks is to decide on how users are allocated to their cells. The problem is of particular importance in forthcoming 5G technologies such as small cell networks. Develop a matching game-based (matching games are covered later in class, a good reference is http://www.econ.ucsb.edu/~tedb/Courses/Ec100C/galeshapley.pdf) approach to match users to their cells, in a small cell setting or to match jobs to virtual machines in a cloud environment. You may apply the Gale and Shapley algorithm and show some simulations.

5. Network Formation Games

Network formation games allow to study how graphs form in a social or wireless setting (see W. Saad, Z. Han, M. Debbah, A. Hjørungnes, and T. Basar, "Coalitional Game Theory for Communication Networks: A Tutorial," IEEE Signal Processing Magazine, Special Issue on Game Theory, vol. 26, no. 5, pp. 77-97, September 2009 and http://www.stanford.edu/~jacksonm/netsurv.pdf). In this project, your goal is to develop a user

interface that allows to define a simple network formation game and show how the graphs form, based on any known algorithm.

6. Multi-Player Educational Game

Develop a simulator or application that allows implementing any of the games studied in class in an actual "game" setting where the players have an interface to choose their strategies and then run the game to show the equilibrium.

7. WiFi Direct

Develop an application that utilizes the new WiFi Direct standard (http://wireless.kernel.org/en/developers/p2p/) to implement an example game-theoretic setting such as the forwarder's dilemma or the peer-to-peer incentive game studied in class.