NYU WIRELESS Annual Industrial Affiliates Board Meeting Minutes

Location: 2 Metrotech Center, 10.099, NYU Polytechnic School of Engineering

Brooklyn, NY

April 8, 2015

11am- 6:15 pm

# Participants

Affiliate board members:

* Samsung: Charlie Zhang (Rakesh Taori and Jeongho Park were unable to attend)
* NI: James Kimery, Ahsan Aziz
* L3: Randal Sylvester, Paul DeLia
* Qualcomm: Tom Richardson, Sundar Subramaniam (Ashwin Sampath indicated that he could not attend)
* Huawei: Peiying Zhu, Yi Wang
* Nokia: Amitava Ghosh, Paul Mertz
* Intel: Geng Wu, Nageem Himayat (Roya Doostneiad attended later public components)
* AT&T: Rittwik Jana
* Ericsson: Ali Khayrallah, Mangus Frodigh
* Straight Path: Jerry Pi, David Jonas
* Keysight: Roger Nichols, Greg Van Wiggeren
* SiBeam: Sohrab Emami (Khurram Sheikh came later)
* Cable Labs: Dan Rice, Belal Hamzeh
* InterDigital: Robert DiFazio, Doug Castor

NYU WIRELESS:

* Ted Rappaport. Director. appeared by video
* Associate Directors: Sundeep Rangan, Dennis Shasha, Dan Sodickson
* Other faculty: Shiv Panwar, Elza Erkip, Yao Wang, Justin Cappos, Lakshmi Subramanian, Davood Shahrjerdi

Sundeep: please fill in other participants Dr. Bloom etc.

# Introductions

* The board meeting was called to order by Prof. Rangan at 11:05 am.
* Prof. Rappaport provided introductory remarks and welcome in a pre-recorded video. He could not attend due to illness, but regretted not coming.
* The affiliates and NYU faculty briefly introduced themselves.
* Dean Sreenivasan welcomed the board and thanked them for their support. He explained that, being a small school, the vision was to concentrate on a few centers for excellence and wireless was one of them. There was a brief period of questions on the nature of the merger and admissions.

# Year in Review

## Overview of the Schools

* An overview was presented of NYU and the three participating schools. All details can be found in the slide deck.
* Prof. Rangan began with an overview of NYU, the prestige of the university and the benefits that the School of Engineering obtains via its affiliation with the school
* The ECE department in particular has shown rapid increase in ranking, moving to 47th.
* Prof. Sodickson described the NYU School of Medicine stating that it too is on the rise and is one of the top 10 schools in the country. He described the particular interest by CIO in wireless solutions.
* Prof. Shasha described the Courant school highlighting its prominence in applied math and computer science. He noted that it has particular strengths in machine learning, graphics and big data. He mentioned that two prominent CS professors – Yann Lecun and Rob Fergus – are heading Facebook’s big data initiative.

## Overview of NYU WIRELESS

* Affiliate membership is growing indicating strong interest in the work at NYU WIRELESS.
* There was some discussion on how many affiliates do we intend to grow to. There was some concern that, after some point, we will not be able to service all the affiliates since there is a finite number of students and faculty. However, it was widely believed that we could grow to at least twenty.
* In discussing the benefits, some affiliates said they did not know the procedures to get access to the propagation database and resume book. Dennis stated that NYU WIRELESS staff will give them instructions.

## Recent Accomplishments

* Prof. Rangan overviewed key technical contributions, grants and publications in the mmWave space. Details are in the slide deck, and demonstrate that NYU WIRELESS is leading academia in the space.
* NYU WIRELESS involvement in the standards and regulatory bodies was also reviewed including the contributions to the FCC NoI 14-177. Ericsson, Nokia and others suggested that our language was bold and perhaps valid, but generally felt that the NYU WIRELESS statements to the FCC should have been more measured and cautious. Nokia in addition thought the response incorrectly equated 5G with mmWave, which is narrow-sighted since 5G encompasses many technologies, mmWave being only one of them.
* That being said, some felt that an academic institution has the unique ability to be more honest and bold and the strong statements were valuable. In particular, academic institutions are perceived as having less bias due to lack of commercial interest.
* In any case, it was agreed that should NYU WIRELESS contribute to the FCC in the future, they should be more conscious of the more slow and careful process that would be taken at many affiliate companies. At a minimum, NYU WIRELSS should provide the affiliates more time in their response and a heads-up when the drafts are coming.

## Budget

* A detailed budget was described. Details are on the slides which show the breakdown of expenses for FY15 an FY16 (estimated).
* As requested by the board, greater than 60% of the affiliate revenue were allocated to core research in the form of board sponsored projects, faculty distributions and research-related travel.
* The high-level breakdown was accepted by the affiliates. However, some expressed that the expenses lumped into “research-related travel” could be better clarified.
* Due to the addition of affiliates, the FY16 budget would be increased. It was proposed to allocate the additional funds in three areas:
	+ Increase in projects from $390k to $600k
	+ Hiring of three postdocs at a total cost of $180k. One was Marco Mezzavilla for MAC / network layer research. He is already employed by NYU WIRELESS and has been coordinating all the projects. He is currently working under an NSF grant. A second was for Aditya Dhananjay, a computer science student who would lead the prototyping work – a key research component. He has already been working extensively with the NI platform as part of his doctoral dissertation. A final postdoc would be for someone in the RF systems area. This position would need to be hired.
	+ Hiring of an office manager staff at a cost of approximately $70k, depending on the experience. The current staff is overwhelmed and somewhat junior.

This allocation would preserve and, in fact, increase the percentage allocation into core research. The budget including all the hiring plans was approved.

## Other

* Prof. Panwar, the ECE department, head gave an overview of the student recruitment efforts. (See slides for details). It was emphasized that students are a key focus of the department. By several metrics, the ECE graduate students – both PhD and masters – have improved dramatically. In addition, the department has reallocated significant funds for graduate students.
* Prof. Rangan described the ERC effort presented at the 2014 board meeting (See slides). NYU WIRELSS along with other academic institutions and the support of affiliate members applied for an ERC in circuits and photonics for massive phased arrays in the sub-THz regime. While the proposal made it to the final round, it was not one of the four proposals funded. Nevertheless, the proposal built several contacts that could provide avenues of research going forward. The affiliates support was appreciated.

# Board Sponsored Projects

## General Discussion

* Prof. Rangan opened the discussion saying that the main goal of the projects is to deliver value to the affiliates and wanted an open discussion on what projects were honestly valuable and what measures can be done to ensure continued support by the affiliates.
* There was a review of the funding process agreed from the previous board meeting. As per the board’s recommendations, approximately 60% should be allocated to research projects. Of that, 70% should be allocated to the projects directly aligned in the board-directed focus area of mmWave communication. The remaining 30% should be allocated to other more exploratory research in order to present the affiliate companies new ideas (See details on the slides).
* A complete list of all the projects and the budgets was presented and shown on the slides. The projects cover the full stack of mmWave communications from channel measurements, signal processing, circuits, MAC-layer research, networking and application layer. In addition, one project is currently being pursued outside the direct mmWave space on a “sensibility testbed”.
* There was a widespread feeling that the communication on the projects was poor at showcasing what was potentially good research. The board was impressed with the variety of the projects, but felt they were hearing of many of the projects for the first time.
* In addition, the once per year review was not sufficient, and many board members would like to be more engaged on a regular basis.
* Also, the board re-emphasized that information on these projects is vital for securing funding in their companies to demonstrate the value that NYU WIRELESS brings.
* To address these issues, it was decided that NYU WIRELESS would consider creating web pages (possibly in an affiliate protected area) on the status of each project including:
	+ Overall description of project including goals
	+ Prose description of progress
	+ Publications
	+ Include posters of any presentations
	+ Links to the students and professors involved.
	+ Links to any software, especially modeling software

These could be updated on a quarterly basis or whenever activities have occurred. There should be a mechanism for alerting the affiliate members of the progress

* It was explained that the affiliate money is generally only a portion of the total funds for any project. Thus, affiliate money is being “leveraged” with other research grants. The board appreciated this, and suggested that NYU WIRELESS show both the affiliate contribution and total funds allocated to each project. If NYU WIRELESS can quantify the degree of leveraging, it will greatly assist the affiliate fund raising.

## Specific Projects

* The faculty presented various projects covering a wide range of aspects of mmWave communication. Most details are on the slides. Some main discussion points are as follows.
* Channel measurements: It was widely-agreed by the board that his project, led by Prof. Rappaport’s group, represents one of the main points of leadership in the center. Prof. Rangan emphasized the two main directions going forward: (i) temporal measurements characterizing the variability in the channel and (ii) multi-base station measurements to assess outage and macro-diversity. Both of these measurements have not been done by any other group and are the main unknowns in assessing system performance.
* MmWave MAC layer design: This project, led by Profs. Rangan and Panwar, was completely new to the board. However, there was an appreciation of the main focuses particularly directional search. Several of the affiliate companies were considering various similar issues.
* MmWave biological effects: This project, led by Profs. Sodickson and Collins, of NYU SOM, was the second of the two projects where the board felt we had a clear leadership in the field. This project had considerable interest in the results of this work and several of the affiliates were in contact with the faculty and students involved.
* Spatial channel estimation: A few of the affiliates expressed interest in compressed sensing methods. It was agreed that the next phase for dynamic channel models and tracking would be particularly interesting.
* Low-power ADC: It was agreed that this was an important area, and in particular, the limits of bandwidth under power constraints were interesting. There are several other signal processing problems as well in the low resolution range, all of which will be of interest to the affiliates. However, the general feeling is that the results right now are preliminary. It was agreed to try to follow up with the affiliate companies to get better power estimates and understand the actual hardware constraints better. Ericsson also pointed out that, for very low dynamic range solutions, AGC and interference / blocking issues should be considered.
* Prototypes: The prototyping system attracted a lot of interest. It was agreed that the configurable ns3 model could have a lot of value for the affiliates, and would have some benefits over custom system level simulation platforms that are typical at the companies. In particular, several companies said they would be interested in the results of this work. The integration with real-time NI platform was particularly interesting. However, there was lack of clarity on exactly to what extent the current system is real-time. It was agreed to get that clarified. The channel sounder was, of course, the main attraction to the board as it had enabled the measurements.
* Stochastic congestion control: This project, run by Profs. Subramanian and Panwar, was also completely new to the board, but elicited a lot of interest. It was the only project looking at the network layer and above. There was wide agreement that current congestion control mechanisms such as TCP cubic would have to be assessed and perhaps redesigned in the presence of mmWave. There was some discussion on where the split TCP could be implemented in the core network (i.e. S-GW or closer to the base station). This led to some discussion of cellular / EPS architecture evolution, particularly with the need to support third party infrastructure / sharing. AT&T suggested that TCP proxies and split TCP are already implemented to some extent in today’s networks and thus may be feasible in the mmWave context.
* Sensibility Testbed: This project by Prof. Cappos also attracted some interest, particularly in the ability to gather real data from large numbers of devices.
* Video adaptation: This project gathered interest since there was a general feeling of the need to look at application layer and use cases for mmWave.

# Research Directions

* There was a short discussion on directions moving forward.
* Some parts on new areas were reiterated in the feedback session and are summarized there.
* There was a discussion of hiring an RF circuits faculty. It was explained that NYU is making significant efforts in this regard. NYU tried to recruit a senior person in the field, but that fell through last minute. In addition, it has been a target area in our search for the last two years, but we have found superb candidates in other areas, including devices and architecture.
* There was some skepticism that a department can create a critical mass sufficient to make an impact in an area like circuits since most successful universities have at least 5 faculty in the area and a large amount of equipment. NYU said that we would tried to clarify the plan and what exactly were the goals of such a position.
* It was also discussed that we are in the process of hiring a postdoc, and it was widely felt that that would be more successful, since that can be more aligned with the mmWave work. SiBeam, which has lots of experience in this area, suggested that what we hire is an “RF systems” person whose specialty is really integrating existing technology into an overall system.

# Board Feedback

* The board requested to move this section before the poster session, with a brief follow up on the students later.
* The board met together alone for approximately 20 mins. Then, there was a short discussion.
* Overall, the board was very happy with the research directions and output of the center. In particular, they re-emphasized that NYU WIRELESS were clear leaders in channel modeling and biological effects. In addition, we were pursuing a large number of topics of interest across the mmWave space.
* However, they felt that, for the discretionary component of the research, they would like to see more “pie-in-the-sky” ideas. These could include flexible electronics that Prof. Shahrjerdi presented, sub-THz electronics.
* Also, there is a lot of interest in understanding use cases such as 5G, operating room work, 5G in video, assisted driving, and augmented entertainment.
* In particular, there was great interest in understanding wireless technology in the hospital. At the previous board meeting, it was felt that the wireless health projects, while interesting, were difficult to connect to projects at the affiliate companies. However, now there would beinterest in understanding operating rooms and hospitals in general as a use case for wireless. There was some discussion on bandwidth / latency requirements, and whether IoT is a technology that applies in a hospital setting. Prof. Marc Bloom would follow up on this with the affiliates.
* As another general feedback, the board felt that since the projects were of great interest, they would prefer to have more communication and opportunities to be engaged. We will arrange live/recorded quarterly presentations by webcast of the projects.
* It was agreed that starting next year, a new format with increased time for posters was preferred.

# Student Poster Session and Feedback

* The board met with the students over posters and demos for approximately 2.5 hours.
* The board provided a brief feedback. Prof. Rangan requested that the board be completely honest.
* Overall, the board said the poster presentations had improved considerably. Students were more prepared and gave more precise, clear statements.
* The projects themselves were of considerable interest.
* Many of the students were very high quality, and several companies said they would consider hiring the students for internships.

The Board meeting was adjourned at 6:15 pm