Fraida Fund

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Affiliation

Research Assistant Professor

Center for Advanced Technology in Telecommunications (CATT), NYU WIRELESS,
Department of Electrical and Computer Engineering,
NYU Tandon School of Engineering, Brooklyn, NY.

Education

2012-2018   **PhD in Electrical Engineering**

NYU Tandon School of Engineering, Brooklyn, NY.

PhD Advisor: Professor Shivendra S. Panwar.
PhD topic: Economics of resource sharing in millimeter wave wireless networks.

2012   **Bachelor of Science in Electrical Engineering**

Polytechnic Institute of New York University, Brooklyn, NY.

Bachelor of Science in Electrical Engineering, minor in Computer Science
I started my B.S. at Brooklyn College of the City University of New York (2008-2010) and then
transferred to NYU (2010-2012).

Publications

Daisy Roberts, Ashutosh Srivastava, **Fraida Fund**, and Shivendra Panwar. "Demo:
Tackling the latency divide with Copa". In *2021 IEEE INFOCOM International Workshop
on Computer and Networking Experimental Research Using Testbeds (CNERT '21) (to
appear)*, May 2021.

Bintia Keita, Ashutosh Srivastava, **Fraida Fund**, and Shivendra Panwar. "Demo:
Experimental evaluation of the impact of Tor latency on web browsing". In *2021 IEEE
INFOCOM International Workshop on Computer and Networking Experimental Research
Using Testbeds (CNERT '21) (to appear)*, May 2021.

Caglar Tunc, Mustafa F. Özkoç, **Fraida Fund**, and Shivendra S. Panwar. "The blind
side: Latency challenges in millimeter wave networks for connected vehicle applications".
IEEE Transactions on Vehicular Technology, 70(1):529–542, 2021.

Fraida Fund, Shahram Shahsavari, Shivendra Panwar, and Elza Erkip. "A model for joint engineering-economic analysis of cellular systems". *IEEE Wireless Communications Letters*, 10(2):344–348, 2021.

Ashutosh Srivastava, **Fraida Fund**, and Shivendra Panwar. "An experimental evaluation of low latency congestion control for mmWave links". In *INFOCOM 2020 Workshop on Computer and Networking Experimental Research using Testbeds (CNERT 2020)*, Toronto, Canada, July 2020.

Rajeev Kumar, Athanasios Koutsaftis, **Fraida Fund**, Gaurang Naik, Pei Liu, Yong Liu, and Shivendra Panwar. "TCP BBR for ultra-low latency networking: Challenges, analysis, and solutions". In *2019 IFIP Networking*, 2019.

Shahram Shahsavari, **Fraida Fund**, Elza Erkip, and Shivendra Panwar. "Capturing capacity and profit gains with base station sharing in mmwave cellular networks". In *INFOCOM 2020 Workshop on Millimeter Wave Networks and Sensing Systems (mmNets)*, pages 603–609, 2018.

Fraida Fund, Shahram Shahsavari, Shivendra Panwar, Elza Erkip, and Sundeep Rangan. "Resource sharing among mmwave cellular service providers in a vertically differentiated duopoly". In *IEEE ICC 2017 Next Generation Networking and Internet Symposium (ICC'17 NGNI)*, Paris, France, May 2017.

Caleb Smith-Salzberg, **Fraida Fund**, and Shivendra Panwar. "Bridging the digital divide between research and home networks". In *2017 IEEE INFOCOM International Workshop on Computer and Networking Experimental Research Using Testbeds (CNERT '17)*, Atlanta, GA, USA, May 2017.

Fraida Fund, Shahram Shahsavari, Shivendra S. Panwar, Elza Erkip, and Sundeep Rangan. "Do open resources encourage entry into the millimeter wave cellular service market?". In *Proceedings of the Eighth Wireless of the Students, by the Students, and for the Students Workshop*, S3, pages 12–14, New York, NY, October 2016.

Vicraj Thomas, Niky Riga, Sarah Edwards, **Fraida Fund**, and Thanasis Korakis. "GENI in the classroom". In Rick McGeer, Mark Berman, Chip Elliott, and Robert Ricci, editors, *The GENI Book*, pages 433–449. Springer International Publishing, 2016.

Fraida Fund, Regina Lin, Thanasis Korakis, and Shivendra Panwar. "How bad is the flat earth assumption? Effect of topography on wireless systems (invited paper)". In *The 2016 International Workshop on Wireless Network Measurements and Experimentation (WiNMeE'16)*, pages 50–54, Tempe, USA, May 2016.

Fraida Fund, S. Amir Hosseini, and Shivendra S. Panwar. "Under a cloud of uncertainty: legal questions affecting Internet storage and transmission of copyright-protected video content". *IEEE Network*, 30(2):32–38, March 2016.

S. Amir Hosseini, **Fraida Fund**, and Shivendra S. Panwar. "(Not) yet another policy for scalable video delivery to mobile users". In *Proceedings of the 7th ACM International Workshop on Mobile Video*, MoVid '15, pages 17–22, Portland, OR, March 2015. ACM.

Fraida Fund, S. Amir Hosseini, and Shivendra S. Panwar. "More bars, more bang for the buck: Channel-dependent pricing for video delivery to mobile users". In *Proceedings of the 2014 IEEE INFOCOM Workshop on Smart Data Pricing*, Toronto, Canada, April 2014.

Yanyan Zhuang, Eleni Gessiou, Steven Portzer, **Fraida Fund**, Monzur Muhammad, Ivan Beschastnikh, and Justin Cappos. "Netcheck: Network diagnoses from blackbox traces". In *Proceedings of the 11th USENIX Symposium on Networked Systems Design and Implementation*, NSDI '14, Berkeley, CA, April 2014. USENIX.

Fraida Fund, Cong Wang, Yong Liu, Thanasis Korakis, Michael Zink, and Shivendra S. Panwar. "Performance of DASH and WebRTC video services for mobile users". In *Proceedings of the 2013 20th International Packet Video Workshop*, PV '13, San Jose, CA, December 2013.

Fraida Fund, Thanasis Korakis, and Shivendra Panwar. "Implementation of a protocol for cooperative packet recovery over hybrid networks". In *Proceedings of the 8th ACM International Workshop on Wireless Network Testbeds, Experimental Evaluation and Characterization*, WiNTECH '13, Miami, FL, September 2013. ACM.

Fraida Fund, Cong Wang, Thanasis Korakis, Michael Zink, and Shivendra Panwar. "GENI WiMAX performance: Evaluation and comparison of two campus testbeds". In *Proceedings of the 2nd GENI Research and Educational Experiment Workshop*, GREE '13, Salt Lake City, Utah, USA, March 2013.

Other Presentations

2020 **Panelist**
2020 ACM Sigcomm Education Workshop and Community Discussion, Panelist in Community Resources session, also contributed whitepaper on "Teaching computer networks with GENI".

2020 **Panelist**
2020 New England Workshop on Software-Defined Radio (NEWSDR 2020), Panelist in Open Source Software in SDR session.

2017 **Tutorial**

"Man-in-the-middle attack on a WiFi hotspot": using wireless testbeds on GENI for network security research, GENI Regional Workshop at University of Oregon, Eugene, OR.

2017 **Demo**

"An Open-Access Research Testbed for Visible Light Communication" at 4th ACM Workshop on Visible Light Communication Systems, at MobiCom 2017, Snowbird, UT. The first author on this work is a high school summer research student that I supervised..

2017 **Seminar presentation**

"An economic perspective on spectrum and infrastructure sharing in millimeter wave cellular networks" presentation at Trinity College, Dublin; Imperial College, London; and Telecom ParisTech, Paris.

2012-2017 **Tutorial introduction to wireless experimentation on GENI**

13th, 14th, 15th, 16th, 18th, 19th, 20th, 21st, 22nd, 23rd GENI Engineering Conferences, 2017 GENI Regional Workshop at Florida International University.

2016 **Run your own classroom spectrum challenge**

GRCon '16 (2016 GNU Radio Conference), Boulder, CO.

2016 **"Run My Experiment on GENI" tutorial**

2016 GENI Regional Workshop at Arizona State University, Tempe, AZ.

2015-2016 **Experimenter-Educator-Developer roundtable panel**

23rd, 24th GENI Engineering Conferences.

2014 **Experiences using GENI in networking classes**

Introduction to GENI workshop at Morgan State University, Baltimore, MD.

2014 **Other research presentations (seminars)**

Hebrew University of Jerusalem; Bar Ilan University; Jerusalem College of Technology (Machon Lev), Israel.

Honors and Awards

2011-current **Best Paper/Poster/Demo Awards**
Reproducibility award at CNERT workshop at INFOCOM 2020, "An Experimental Evaluation of Low Latency Congestion Control for mmWave Links".
Best Paper Award at CNERT workshop at INFOCOM 2017, "Bridging the digital divide between research and home networks". The first author on this work is a high school student doing research under my supervision.
Best Poster Award at IEEE Sarnoff Symposium 2016, "Do open resources encourage entry into the mmWave cellular service market?"
2nd Prize Demo Award at NYC Media Lab Summit 2016, "Bridging the empathy gap between web developers and users"
Best Demo Runner Up at 23rd GENI Engineering Conference (2015), "GENI for Classes and GENI for the Massess"
Best Research Paper Award at 2013 GENI Research and Educational Experiment Workshop, "Performance: Evaluation and Comparison of Two Campus Testbeds".

Student Travel Grants
Support for travel to: 12th GENI Engineering Conference (GEC12) in Kansas City, MO; 8th International Conference on Testbeds and Research Infrastructure for the Development of Networks and Communities (Tridentcom 2012) in Thessaloniki, Greece; 19th Annual International ACM Conference on Mobile Computing and Networking (MobiCom 2013) in Miami, FL.

2017 **Rising Stars in EECS 2017**
Selected to participate in the Rising Stars in EECS 2017 workshop at Stanford University, which aims to bring together top senior Ph.D. and postdoctoral candidates preparing for careers in academia (70 participants were invited out of approximately 370 applicants).

2012 **NSF Graduate Research Fellowship (3 years of support)**
National Science Foundation.

2012 **Honorable Mention, CRA Outstanding Undergraduate Research Award**
Computing Research Association.

2011 **International Engineering Consortium**
William L. Everitt Award of Excellence
Polytechnic Institute of NYU, Brooklyn, NY.

2010 **Jonathan Marc Zimmering Award for Undergraduate Engineering Study**
Brooklyn College of the City University of New York, Brooklyn, NY.

Teaching

Summer 2020   **Adjunct Professor, Introduction to Machine Learning**
NYU Tandon School of Engineering, Brooklyn, NY,
Co-teaching, lead instructor is Professor Chinmay Hegde.

Summer 2020   **Lab Instructor, Internet Architecture and Protocols**
NYU Tandon School of Engineering, Brooklyn, NY,
100% online lab section,
Course instructor: Professor Shivendra Panwar.

Spring 2020   **Adjunct Professor, Introduction to Machine Learning**
NYU Tandon School of Engineering, Brooklyn, NY.

Spring 2020   **Adjunct Professor, Senior Design Project in Computer Engineering (DP II)**
NYU Tandon School of Engineering, Brooklyn, NY.

Fall 2019   **Adjunct Professor, Senior Design Project in Computer Engineering (DP I)**
NYU Tandon School of Engineering, Brooklyn, NY.

Spring 2018   **Adjunct Professor, Senior Design Project in Computer Engineering (DP II)**
NYU Tandon School of Engineering, Brooklyn, NY.

Fall 2018   **Adjunct Professor, Senior Design Project in Computer Engineering (DP I)**
NYU Tandon School of Engineering, Brooklyn, NY.

Spring 2018   **Adjunct Professor, Network Security**
NYU Tandon School of Engineering, Brooklyn, NY,
Co-teaching with Professor Shivendra Panwar.

Fall 2017   **Lab Instructor, Internet Architecture and Protocols**
NYU Tandon School of Engineering, Brooklyn, NY,
100% online lab section.

Fall 2017   **Lab Instructor, Comm. Networks: Analysis, Modeling, and Performance**
NYU Tandon School of Engineering, Brooklyn, NY,
Course instructor: Professor Shivendra Panwar.

Spring 2017   **Lab Instructor, Communication Networks**
NYU Tandon School of Engineering, Brooklyn, NY,
Course instructor: Professor Shivendra Panwar.

Fall 2016   **Scientific Computing and Communication Workshop**
NYU Tandon School of Engineering, Brooklyn, NY,
2-day workshop for newly admitted ECE MS students.

Spring 2016 **Lab Instructor, Comm. Networks: Analysis, Modeling, and Performance**
NYU Tandon School of Engineering, Brooklyn, NY,
Course instructor: Professor Shivendra Panwar.

Fall 2015 **Adjunct Professor, Selected Topics in Wireless Communications:**
Software Defined Radio Laboratory
NYU Polytechnic School of Engineering, Brooklyn, NY.

Spring 2015 **Adjunct Professor, Real-Time Embedded Systems**
NYU Polytechnic School of Engineering, Brooklyn, NY.

Spring 2015 **Lab Instructor, High Speed Networks**
NYU Polytechnic School of Engineering, Brooklyn, NY,
Course instructor: Professor Shivendra Panwar.

Spring 2015 **Lab Instructor, Communication Networks**
NYU Polytechnic School of Engineering, Brooklyn, NY,
Course instructor: Professor Yong Liu.

Fall 2014 **Lab Coordinator, Advanced Topics in Computer Networks:**
Software Defined Radio
University of Thessaly, Volos, Greece,
Course instructor: Professor Thanasis Korakis.

Spring 2014 **Lab Coordinator, Wireless Communications**
University of Thessaly, Volos, Greece,
Course instructor: Professor Thanasis Korakis.

Spring 2014 **Lab Instructor, Communication Networks**
NYU Polytechnic School of Engineering, Brooklyn, NY,
Course instructor: Professor Shivendra Panwar.

Fall 2013 **Lab Coordinator, Advanced Topics in Computer Networks**
University of Thessaly, Volos, Greece,
Course instructor: Professor Thanasis Korakis.

Spring 2013 **Lab Instructor, Wireless Personal Communication Systems**
Polytechnic Institute of New York University, Brooklyn, NY,
Course instructor: Professor Sundeep Rangan.

Mentoring and Outreach

2011-current	**WITest: GENI Wireless Testbed at NYU**

I am responsible for operations of the GENI wireless research testbed at NYU, which is part of a nationwide project to develop testbeds for computer networking research. Since 2012, our facility has supported more than 10,000 hours of use, by over 1,000 users. Initially supporting mostly research, this testbed now supports a wide range of educational and outreach uses as well.

2016-current   **Reproducible Research on GENI blog**

To promote reproducible research on computer networks, wireless, and distributed systems, I run a blog featuring experiments (my own and other contributors') that can be reproduced on the GENI testbed: `http://witestlab.poly.edu/blog/`.

2014-current   **GENI in Education**

As part of my ongoing involvement in the GENI testbed project, I developed a set of experiments on GENI for classroom use. These have been used by instructors from a wide range of institutions. This project was featured on NSF.gov: `http://www.nsf.gov/discoveries/disc_summ.jsp?cntn_id=134570`.

2013-current   **High school summer research students**

Mitashee Das (video delivery over wireless networks, presented at 18th GENI Engineering Conference. Now at Princeton University),

Regina Lin (effect of terrain on wireless signals, presented at 18th GENI Engineering Conference, published in WiNMeE 2016, Now at University of Pennsylvania),

Sharri Glloxhani (software defined radio, now at Stony Brook University),

Jason Shin (software defined radio, now at Case Western Reserve University),

Dolly Devashryee (sharing network infrastructure during outages, presented at NYC Media Lab Summit 2015. Now at NYU),

Benjamin Spiegel (implications of peering agreements for network neutrality, presented at NYC Media Lab Summit 2015. Now at Brown University),

Amaya Munoz (community wireless networks, presented at NYC Media Lab Summit 2016. Now at the University of Wisconsin - Madison),

Caleb Smith-Salzberg (applying realistic conditions to testbed networks, presented at NYC Media Lab Summit 2016, published in CNERT '17)

Nana Bonsu (next-generation applications for wireless networks operating at 60 GHz)

Jazmin Zamora (testbed for visible light communication systems, demo at VLCS '17)

Zoe Wu (realistic background traffic replay in networking experiments)

Farrukh Abdinov (connected vehicle applications over mmWave links, under review)

Minuk Kim (low-latency AR and VR applications over mmWave links)

Daisy Roberts (bridging the latency divide with Copa, demo at CNERT '21)

Bintia Keita (Tor latency, demo at CNERT '21).

2014-current **Undergraduate research students**

Eddie Sitt (location-based games; GENI MOOC),

Michael Shamouilian (anonymity in communication networks),

Samuel Partington (network neutrality),

Saboor Zahir (routing),

Benjamin Kozuch (digital personal assistants),

Kunaal Patade (anonymity in communication networks),

Devora Wiesel (implementation of classic queuing theory examples on GENI),

Kimberly Milner (Hadoop-based recommendation systems; radio machine learning),

Dov Salomon (full duplex wireless),

Shivam Suleria (full duplex wireless),

Enes Krijestorac (full duplex wireless),

Takuya Fukui (investigating Tor using GENI)

Shreeshail Hingane (reducing queuing delay in mmWave networks using AQM)

Youssef Azzam (congestion control in mmWave networks)

Anna Wang (a game-theoretic approach for reducing queuing delay).

2014-current **MS research students**

Parvin Taheri (cross-layer effect of correlated shadow fading),

Ajinkya Kadam (full duplex wireless; software defined radio),

Charalampos Manolidis (with Professor Thanasis Korakis at University of Thessaly; replicating BattleMesh in open wireless testbeds; presented at Wireless Battle of the Mesh 2017),

Ishmita Singh (undestanding consumer fixed broadband performance in the U.S.),

I was also the faculty advisor for the "Spectral Rangers" team of NYU Tandon MS students competing in the 2016 Spectrum Sharing Radio Challenge competition (Spectrum-ShaRC) organized by Virginia Tech University (team placed third).

2011–2013 **Girls Inc. of NYC Project GROW**

Urban Assembly Institute of Math and Science for Young Women, Brooklyn, NY,

Volunteer classroom assistant in an afterschool program for girls in grades 6-8. The program includes homework assistance and elective coursework on digital media skills.

Funding

2019 **Addressing queuing delay at the edge of mmWave 5G networks**
Participant, Gift award from CISCO, $100,000,
PI: Shivendra S. Panwar.

2016 **EARS: Spectrum and infrastructure sharing in millimeter wave cellular networks**
Contributor, NSF Award 1547332, $750,000,
PI: Sundeep Rangan, Elza Erkip, Nicholas Economides.

2013 **EAGER: Design, development and standardization of a new hands-on lab component for use in wireless information systems courses, based on the GENI Wireless research facilities**
Contributor, NSF Award 1258331, $130,000 ,
PI: Thanasis Korakis.

Research Internships and Visiting Research

Summer 2017 **Nokia Bell Labs** Murray Hill, NJ,
Advisor: Katherine Guo.

Summer 2014 **CERTH − The Centre for Research & Technology, Hellas** Volos, Greece,
Advisor: Professor Leandros Tassiulas, George Iosifidis.

Summer 2013 **AT&T Labs Research** Florham Park, NJ,
Advisor: Vaneet Aggarwal, Rittwik Jana, Ioannis Broustis, N K Shankaranarayanan.