NYU WIRELESS

www.nyuwireless.com

NYU WIRELESS Board Meeting

October 23, 2024

Tom Marzetta - Director
Ted Rappaport - Founding Director
Sundeep Rangan, JR Rizzo, Dennis Shasha - Associate Directors

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Agenda

Time	Item
9:30	Welcome & Agenda review, Tom Marzetta
9:35	Opening Remarks Senior Vice Dean Eray Aydil Chandrika Tandon, Chair, NYU Tandon Board Nishant Batra, Chief Strategy & Technology Officer, Nokia
9:50	Industrial affiliates. Introduction / overview (5 minutes each)
10:45	NYU Wireless overview and updates
Noon	Lunch
1:00pm	Faculty lightning talks, 2 minutes each faculty member
2:00pm	Feedback, discussion, brainstorming, industry perspectives, wrap up
3:00pm	Open house & demos

Come to the After Show

October 23, 2024

Wednesday 10/23/24	3:00pm - 5:00pm	**NYU WIRELESS Open House** NYU 6 Metrotech
	5:00pm - 6:30pm	**Exhibits Open for all the registered guests and NYU faculty/students** NYU Gym
	6:30pm - 9:00pm	**Exhibits open for visits** NYU Gym
	6:30pm - 9:00pm	**Welcome Reception with cocktails and light dinner** NYU Gym **Hosts:** Peter Vetter (President of Bell Labs Core Research, Nokia) Thierry Klein (President of Bell Labs Solutions Research, Nokia Bell Labs) *Click to learn more*

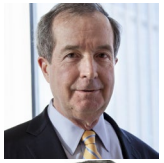
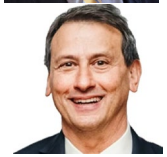
Outline

- NYU Tandon, ECE, an NYU Wireless Overview
- Notable Grants and Achievements
- Discussion points (for later)
  - Improving engagement
  - Industry trends
  - Aspirations and goals

NYU WIRELESS

- Leading academic center in wireless communications
  - 18 faculty, 6 post-docs, research engineers, ~70 PhD
  - 4 faculty at NYU Abu Dhabi
  - 11 industrial affiliates
  - Largest research center in NYU Tandon School of Engineering
- Our mission
  - Fundamental research while cultivating student researchers
  - Offer technical solutions and knowledge for next generations
  - Solve specific problems for industrial affiliates
  - Create leaders and collaboration skills with top students
- Current in force funding
  - > $13 Million/annually from NSF, NIH, CHIPs Act, and corporate sponsors

Directors


- **Tom Marzetta**, Current Director and Distinguished Industry Professor, ECE
  - Originated Massive MIMO
  - Lead author of "Fundamentals of Massive MIMO"
  - Joined NYU 2017 from Bell Labs
  - NAE member
- **Ted Rappaport**, Founding Director and Professor, ECE
  - Pioneer in wireless communications (esp. millimeter wave and WiFi)
  - Author of "Wireless Communications: Principles and Practice"
  - Previously founded major wireless centers at UT Austin, Virginia Tech
  - NAE member, Wireless Hall of Fame, Fellow of National Academy of Inventors
- **Sundeep Rangan**, Associate Director and Professor, ECE
  - > 15 years experience in cellular industry
  - Co-founder Flarion Technologies (developed first cellular OFDM data system, sold to QCOM)
- **Dennis Shasha**, Associate Director and Professor, Courant
  - Machine learning, databases, bio-informatics
- **JR Rizzo**, Associate Director and Associate Professor, NYU School of Medicine
  - Technologies for the blind and visually impaired

New Leadership at NYU Tandon

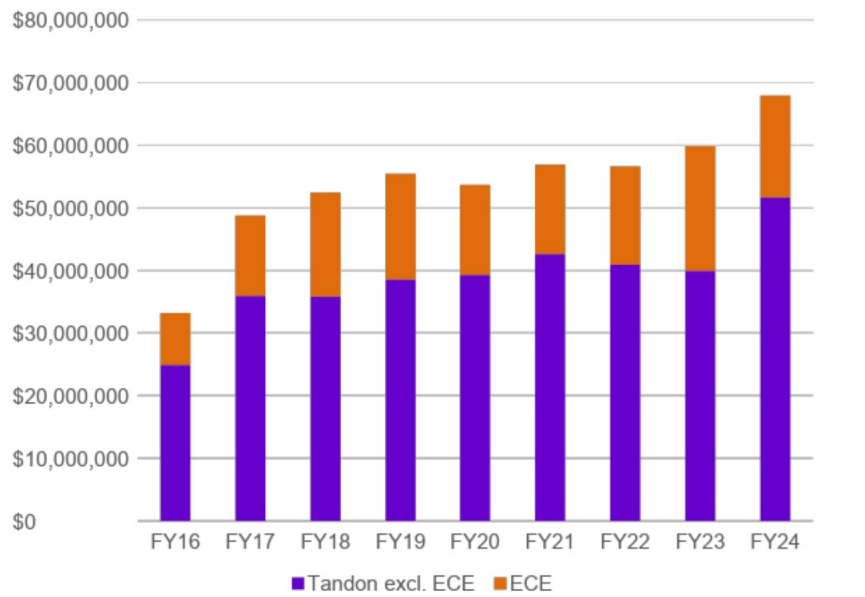
- **Juan de Pablo, Executive Dean**
  - Former Executive VP, University of Chicago
  - Directed Argonne National Laboratory
  - Member NAE, NAS, Mexican Academy of Sciences
  - Polymer Physics Prize from the American Physical Society (2018),
  - DuPont Medal for Excellence in Nutrition and Health Sciences (2016),
  - Intel Patterning Science Award (2015), …

- **Eray Aydil, Senior Vice Dean**
  - Alstadt Lord Mark Professor of Chemical and Biomolecular Engineering
  - Formerly at Bell Labs, University of Minnesota
  - Peter Mark Award
  - Plasma Prize from the American Vacuum Society

Tandon ECE

- 31 Profs –13F, 8 Assoc. 7 Asst, 3 Industry
- 13 IEEE Fellows; 2 NAE; 4 Members NAI
- Students:
  - ~400 UG students;
  - ~1000 Grad students
  - ~140 PhD students
- Ranked 4th in citations/paper in US (QS)
- ECE is 25% of Tandon research budget

Tandon Research Expenditures are growing



Year Twelve!

NYU Wireless Founded, 2012

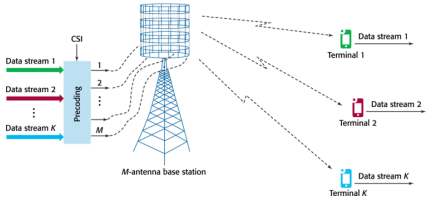
First B5GS 2014

US commercial 5G, ~2020

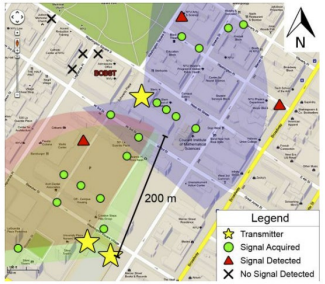
?

6G

Massive MIMO ~2010



MmWave: It Will Work! 2013



3GPP 5G NR First release 2017

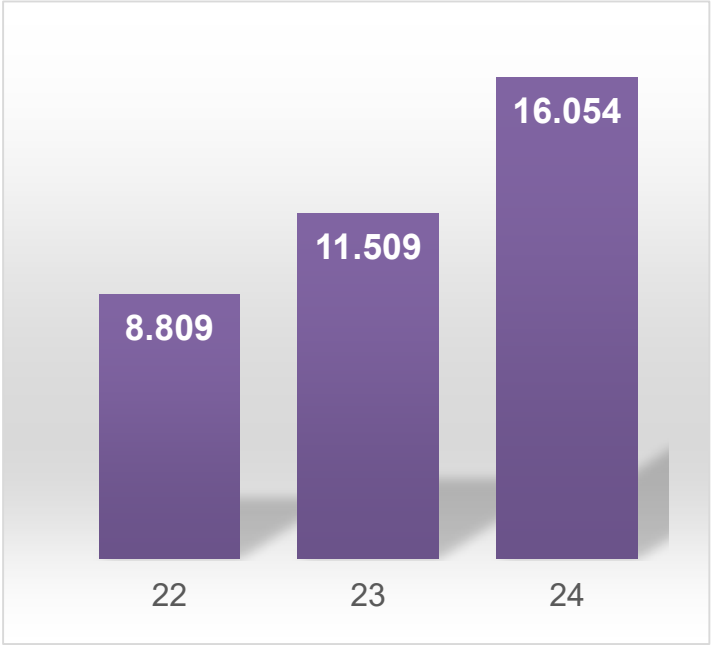
Brooklyn 6G Summit
NYU WIRELESS Workshop

Funding on the Rise

Source	FY2022	FY2023	FY2024
NSF	3,033,081	4,552,361	7,009,235
NIH	2,014,247	2,252,947	2,252,947
DoD	714,173	525,419	560,408
NTIA	0	0	2,000,000
SRC	304,678	0	0
NY State	1,000,000	903,954	1,319,477
Dept of Education	202,264	203,588	203,997
MEC	0	0	1,300,000
Other	541,145	2,171,129	508,262
NYU Wireless affiliates	1,000,000	900,000	900,000
Total	8,809,588	11,509,398	16,054,326

Research multiplier:
$1 from affiliates ≈ $160 research

Total NYU Wireless Funding
($ Millions / year)

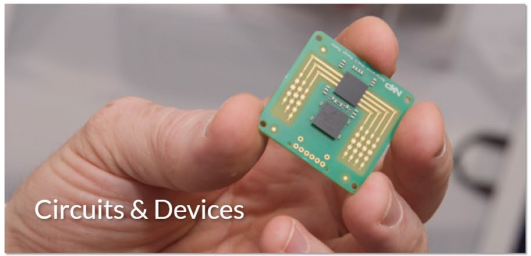


NYU WIRELESS Research Areas

Wireless Communications & Sensing

Networking, Edge Computing & Security

Circuits & Devices



Applications

AI/ML in Wireless

Testbeds & Prototypes

Faculty

Wireless Communications & Sensing


Rappaport


Marzetta


Rangan


Knox


Erkip

Networking


Yong Liu


Panwar

Circuits


Rahmani


Shahrjerdi

Applications


Atashzar


Yao Wang


Rizzo


Shasha


Loianno

Level	
Full professors	9
Associate professors	2
Assistant professors	2
Industry	1
Total	14

Department	
ECE	12
School of Medicine	1
Courant	1

Welcome Annie Nadeem

- Newest faculty at NYU Abu Dhabi
- Research areas:
  - Wireless communications;
  - signal processing;
  - massive MIMO;
  - programmable metasurface applications
- Track co-chair, IEEE VTC Spring 2024
  - Radio Access Technology and Heterogeneous Networks
- Notable Awards:
  - Paul Baron Young Scholar Award from The Marconi Society in 2018
  - National Sciences and Engineering Research Council of Canada (NSERC)'s Postdoctoral Fellowship Award in 2021

NYU Abu Dhabi

Faculty

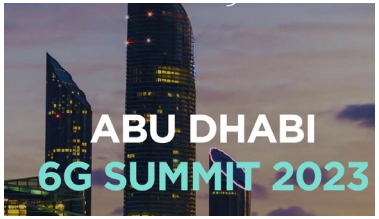
Marwa Chafii
(since 2021)

Murat Uysal
(since 2023)

Annie Nadeem
(2024)

Annual Event

- Co-organized with local universities and industries



Bi-annual Event:

- 6G Training School
- Hosted on NYUAD Campus

Research Topics

- Integrated Sensing and Communication
- Optical Wireless Communications
- Reconfigurable Intelligent Surfaces

UAE Wireless Center

- Submitted 2024
- Erkip, Rappaport PIs from NY

B6GS Summit

- Leading annual global event
- Vision talks by industry leaders
- By and for Industrial Affiliates
- No extra cost, another benefit

IEEE Live Stream

NYU Wireless Workshop

- Brings top researchers to NYU
  - 1.5 day event
  - Every 1.5 years
- Industrial affiliates invited
- June 2024 workshop
  - What are the challenges of FR3 spectrum?
  - Alternative wave propagation physics
  - Communication satellite networks: strategic or volatile?

New IEEE-NYU Cooperation

The IEEE / NYU Channel Propagation product offering

A market-ready Data and Analytics Product requires:

Data

- **Existing proprietary NYU data** campaigns, including raw data, reports and supplementary information
- **New campaign data** for FR3 and FR1, priority for indoor and factory (frequency ranges)

Analytics

- **Premium simulation platform** with capabilities beyond the free NYUSIM
- **Machine learning** capabilities
- **User-friendly interface**

User Access

- **Individual user login** with authentication for institutional access
- **Administrator access** to control user access and continuous data flow

- The data and analytics product will be hosted and delivered by IEEE.

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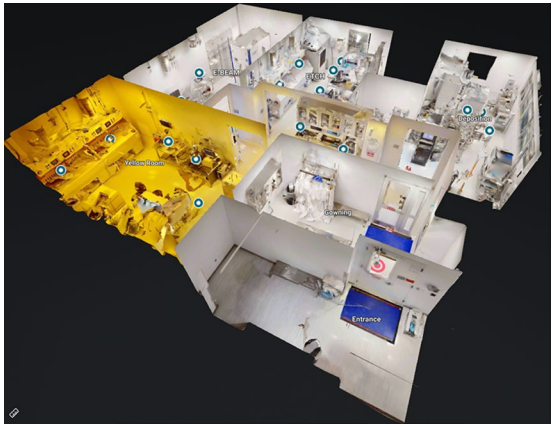
New Quantum Project

- NYU part of new quantum project
  - Improved Materials for Superconducting Qubits With Scalable Fabrication
  - $8.9M project from NORDTECH Chips Act hub
  - NYU component is $1.5M
- Goal:
  - Scalable quantum error correction
  - New materials
  - Innovative quantum circuits, qubit control
  - Will deliver a superconducting PDK at 300mm wafer scale

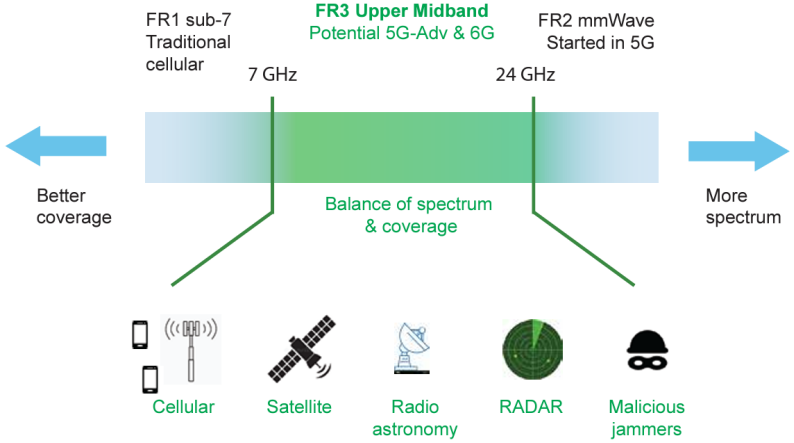


NYU nanofab

NORDTECH
Northeast Regional Defense Technology Hub

NYU Wireless lead
Davood Shahrjerdi

NTIA Grant on FR3




Sundeep Rangan


Hamed Rahmani


Marco Mezzavilla


Aditya Dhananjay, Pi-Radio


Arjuna Madanayake, FIU

- Testing procedures for FR3
- Funded by CHIPs Act
  - Supports translational work
  - Collaboration with industry in telecom
- $2M, Sept 2023 – Aug 2028
- Tasks
  - Task 1: RF conformance and development of an RF board
  - Task 2: Spectrum sharing in cooperative scenarios
  - Task 3: Resiliency testing in adversarial scenarios
  - Task 4: O-RAN integration

ANALOG DEVICES

NSF Grant on Point Cloud Video

- Grant on point-cloud video (PCV) communication
  - Object-Centric, View-Adaptive and Progressive Coding and Streaming of Point Cloud Video
  - Key for immersive applications
  - Massive data requirements
- $1.2M grant from NSF over four years
- Leverages NYU Tandon @The Yard
  - Production facility in Brooklyn Navy Yard
  - Volumetric motion capture
  - A new testbed for immersive PCV capture and communication

Yao Wang

Yong Liu

R. Luke Dubois

A New Multiuser THz measurement facility (NSF:MRI THz Lab) at NYU

Collaborators:

University of Colorado Boulder

FIU Florida International University

University of Nebraska Lincoln

Advisor:

ETH zürich

Vendor Partners:

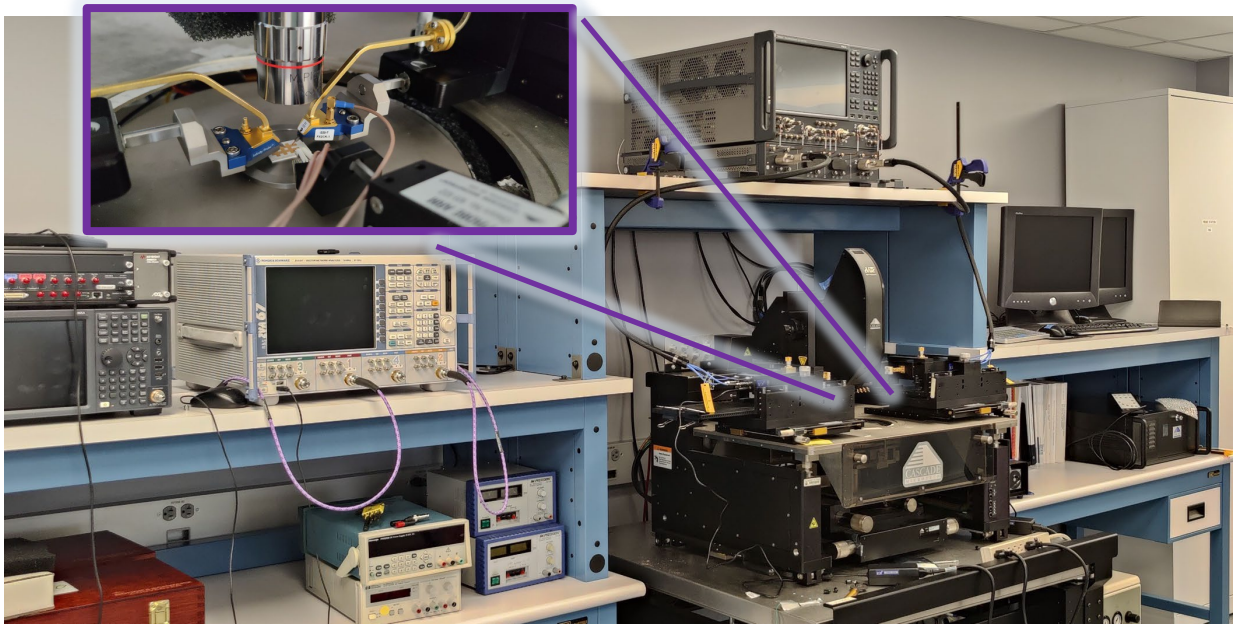
Keysight Technologies

VDI

FormFactor™

MPI Corporation

URL: https://engineering.nyu.edu/thzlab



RFIC Fabrication support:

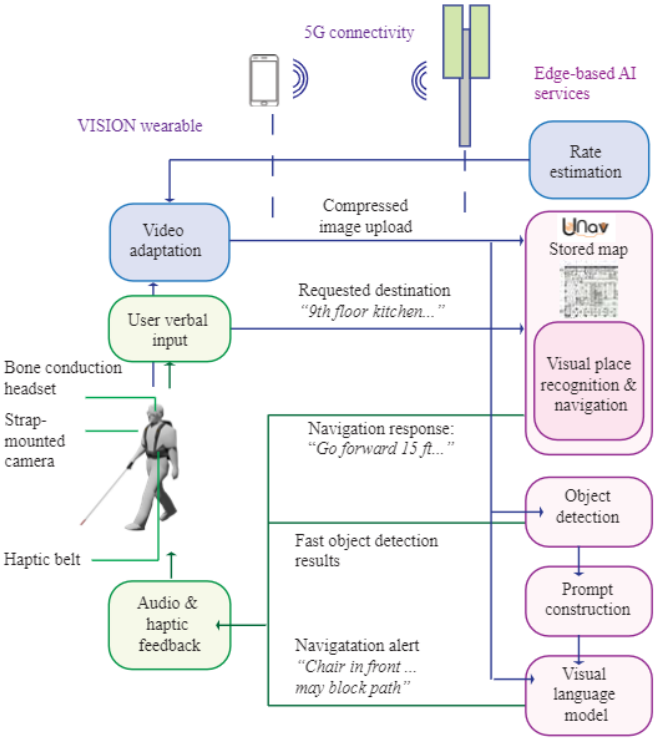
UMC

- **THz Lab** features **state-of-the-art equipment** for **RF propagation and devices** test and measurement, such as **network analyzers and four-port probe stations**.
- An **open hardware library** with a novel **"equipment checkout"** concept **[1]**.

[1] D. Shakya, T. S. Rappaport, D. Shahrjerdi, M. E. Knox, S. Nie, A. Madanayake, Z. Popovic, H. Wang, "Exploring millimeter-wave and Terahertz circuits and systems with a novel multiuser measurement facility," (Accepted*) IEEE Microwave Magazine*, Jul 2023 (to appear Feb. 2024)

NSF Convergence Accelerator Track G

- Connected Wearables for PBLV
  - People with Blindness and Low Vision
- Part of the NSF Convergence Accelerator program
  - Supports translational research to commercialization
  - Collaboration with start ups / industry
- Phase 2: $5M, 2.5 year grant
  - Rizzo (lead) with Rangan, Wang, Mezzavilla from NYU Wireless
  - Other faculty from NYU SoM, ME, Stern
  - Developed wireless OAI-based testbed for experimentation
- Support from Qualcomm and Dell




JR Rizzo


Yao Wang


Sundeep Rangan


Marco Mezzavilla

Notable Awards & Accomplishments

- Tom Marzetta
  - 2025 IEEE Eric E. Sumner Award “For originating the Massive MIMO technology in wireless communications”.
  - 2024 IEEE Communications Society Radio Communications Committee Technical Recognition Award.
- Ted Rappaport
  - IEEE VTS Neal Shephard Propagation Paper award (with former student Shu Sun)
  - Elected IEEE VTS Hall of Fame
- Marwa Chafii
  - General Vice Chair, IEEE WCNC, Dubai 2024 (Murat Uysal was the Awards Co-Chair)
- Elza Erkip
  - TPC Co-Chair, IEEE CTW, Banff 2024
- Dennis Shasha
  - 2023: Senior Member National Academy of Inventors

Notable Awards & Accomplishments

- JR Rizzo
  - Pisart Award for Technological Innovation from Lighthouse Guild (leading NPO for blindness)
  - Appointed to Board of Directors MTA
  - Appointed to LivedX from National Academies
  - Appointed to the Strategic Council for Foundation Fighting Blindness (leading NPO for blindness)
  - Appointed to standing study section for NIH NICHD
  - Appointed to the Advisory Board for lighthouse Guild

- Hamed Rahmani
  - NSF grant: High-Resolution Neural Interface SoC with Meta-Structure-Enhanced Wireless Power Transmission

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Partnering with the Affiliates

- How do we better engage with all of you?
- Monthly seminars?
- Collaborative federally-funded projects:
  - NSF Convergence Accelerator with Qualcomm and Dell
  - NTIA NOFO-1: With Analog Devices
  - NTIA NOFO-2: With Analog Devices and Nokia
  - CHIPs Act: Many possibilities
- Regular meetings with individual faculty
- Seed projects?

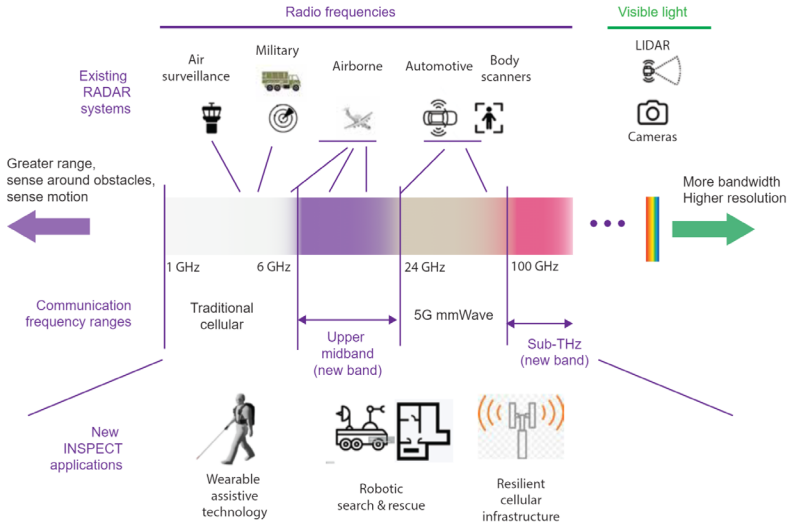
New Federal Funding Opportunities

- Billions in new funding available
  - CHIPs Act and Microelectronics Commons
  - Public Wireless Innovation Fund
- NSF TIP Directorate
  - NSF Convergence Accelerator
- Emphasis on wireless & security
- NYU Wireless has recent successes
  - NORDTECH $1.5 million
  - NSF Convergence Accelerator $5M
  - NTIA NOFO-1 $2M
- We have hired in circuits
- More opportunities are available

NORDTECH
Northeast Regional Defense Technology Hub

National Center Leadership

- NYU Wireless should lead at least one major center
  - Example: ERC $20M+
- Goal: Lead a $20M+ center (1-3 years)
- We have attempted before
  - NSF Spectrum Initiative
  - AI Institute,
  - RIE, …
- NYU collaborates on:
  - NSF Spectrum-X (ND lead)
  - COSMOS (Rutgers lead)
  - ComSenTer (UCSB lead)
- Submitted proposal for ERC Gen-4
  - RF Sensing

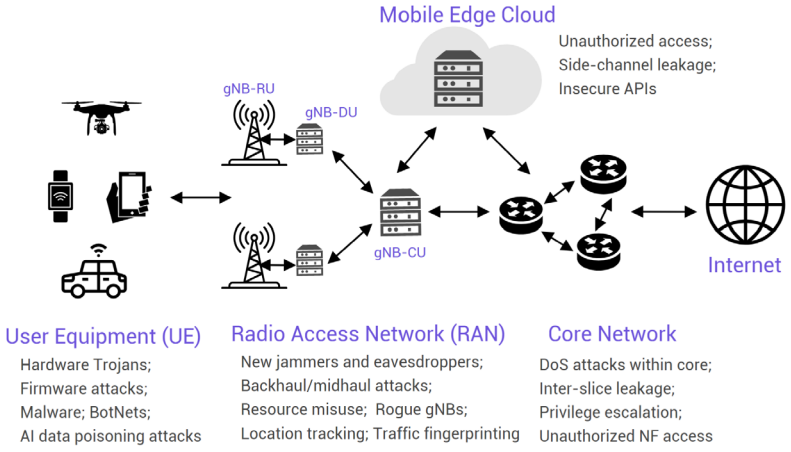


DoD and Security Related Funding

- Grow DoD-related funding
  - Massive funding in defense space for wireless
  - Many agencies have calls: DoD, DARPA, ONR, CIA, …
  - Grow network of contacts (1 year)
  - At least one more major DoD project (1-2 years)
  - Goal: Grow to $4M+ in DoD funding (5 year)
  - Goal: Add a defense contractor to affiliate board (3 year)

Christina Poepper, NYU-AD

- Security
  - NYU-AD has leader in 5G security (Poepper)
  - NYU CCS
  - Large emphasis on wireless security
  - NYU was finalist in $10M SaTC program on 5G security
  - Goal: Significant pubs in UseNix, … (1-3 years)
  - Goal: Large center in security (5 years)



Collaborative Efforts

- Grow impact in semiconductor space
  - NYU has growing chips design expertise
  - 3 recent hires in ECE (Reagan, Rovinskii, Rahmani)
  - Experts in related areas: Privacy, AI acceleration
  - Massive funding from CHIPs Act
  - Involvement in at least one more major CHIPs ACT project (1 year)
  - Goal: Publications in top circuits / comp architecture venues (1-3 years)
  - Goal: Grow to $4M+ annual semiconductor-related funding (5 year)
  - Goal: Become global leader in wireless digital design as rated by publications (5 year)

Brandon Reagan

Austin Rovinskii

Hamed Rahmani

- Medicine
  - NYU has world-leading School of Medicine & new BME program
  - Existing collaborations with Rizzo, Wang, Atashzar
  - Healthcare was focus of several recent proposals
  - Goal: One more large NSF / NIH project in wireless ($5M+) (3 years)

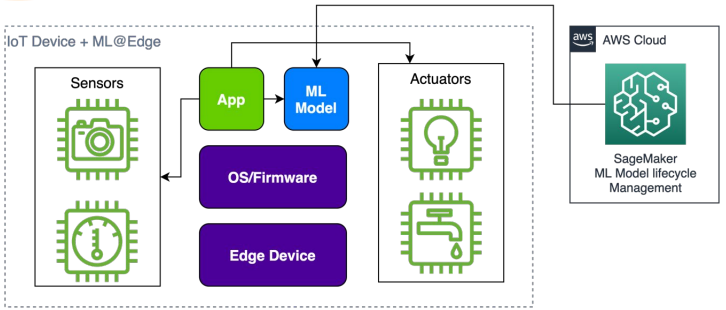
Prospective Affiliates in Big Tech

- Expanding interest in wireless in Big Tech
  - Nvidia
  - Amazon mobile edge cloud
  - Google
  - Facebook
- Our students go to these companies
- Nvidia is speaking at B6GS
- Goal:
  - Recruit at least one new affiliate from this space (2 years)
  - Recruit 2 new affiliates (5 years)
  - Increase presence at top CS conferences (NeurIPS, …) (3 years)

NVIDIA AI Aerial Building Blocks for Wireless Research and Development

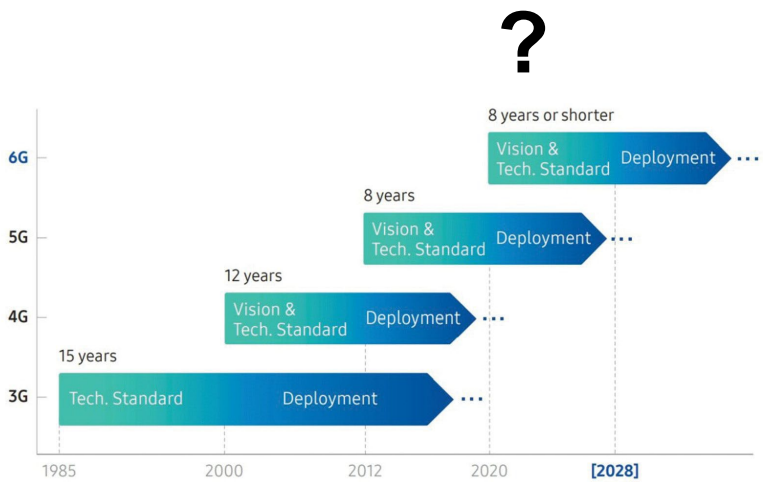
Google Pixel

aws



Impact on 6G

- NYU Wireless played leading role in 5G
- Direction of 6G remains unclear
  - What are the goals?
  - What are the use cases?
  - What are the technologies?
- We are leading in two major areas:
  - Energy efficiency (Waste factor)
  - Upper mid-band
- NYU Wireless can help define the future
- Goal:
  - At least one landmark paper / technical innovation on 6G (1-3 years)
  - Significant 6G basic research funding ($2M+ / year) (5 years)



Thank You!


NIH


SRC
Semiconductor
Research
Corporation


ANALOG DEVICES
AHEAD OF WHAT'S POSSIBLE™


DELL
Technologies


ERICSSON


interdigital


KEYSIGHT


MEDIATEK


NOKIA


NSF


QUALCOMM


SHARP
Be Original.


UMC