TESTING THE LIMITS

A pioneering, real-world lab for 5G wireless technology comes to Harlem.

Fourth-generation wireless, better known as 4G, turned mobile phones into movie-streaming platforms, but the next wireless revolution promises more than speedy downloads. It could pave the way for surgeons operating remotely on patients, cars that rarely crash, and events that can be vividly experienced from thousands of miles away.

To get us there, Columbia Engineering faculty are helping to create COSMOS, a state-of-the-art urban proving ground for a new generation of wireless technologies and applications funded through a $22.5 million grant from the National Science Foundation's (NSF) Platforms for Advanced Wireless Research (PAWR) initiative.

This open-access platform will allow researchers from anywhere in the country to log in and try out their ideas for improving network performance and creating city-focused applications. Its high-bandwidth, low-latency network is expected to allow these applications to transmit data faster than one gigabit per second and reduce response times to a few milliseconds, improving performance 10-fold over current wireless networks.

"This is going to be a unique outdoor lab for advanced wireless networking technologies," said Gil Zussman, associate professor of electrical engineering and the Columbia principal investigator on the project. Zussman is collaborating with fellow electrical engineering professors—Harish Krishnaswamy, an expert in millimeter wave (mmWave) technology and full duplex wireless, and Zoran Kostic, who focuses on smart cities and mobile data systems—and computer science and electrical engineering professor Henning Schulzrinne, who contributes dynamic spectrum and edge cloud computing expertise to the project. All of the team members are affiliated with Columbia's Data Science Institute (DSI). "Having an opportunity to run experiments in a real-world environment like COSMOS can take wireless networking and smart cities research to a whole new level."

Covering one square mile in West Harlem, the testbed is bordered by City College to the north, Columbia University's Morningside Heights campus to the south, the Hudson River to the west, and Apollo Theater to the east.

By Kim Martineau, with additional reporting by Melanie Farmer

Opposite page, from top: Photo courtesy of Phoebe Arnold; photo courtesy of Karin Weidner Mubanda

By **2020**, the number of internet-connected devices is expected to grow to **20 billion**, creating an urgent need for infrastructure to rapidly process all that data.

Data processing will be handled by on-site "edge cloud" servers rather than in far-off data centers.

COSMOS will tap previously unused mmWave radio spectrum bands and integrate optical fibers underground with radio antennas and other equipment, on approximately 50 light poles and city rooftops, including one large node already placed atop Mudd. The network will host about 200 experimental mobile devices.

Smart traffic intersections are key to the deployment of autonomous vehicles in urban environments. Low latency allows rapid exchange of data between vehicles, city infrastructure, and pedestrians, including high-bandwidth video. Edge computing resources facilitate real-time computation of positions and trajectories, and collaborative prediction of optimal traffic flows using deep learning techniques.

COSMOS will make extensive use of dark fiber running along the Broadway and Amsterdam Avenue corridors.

The project also provides hands-on STEM training for teachers, students, and West Harlem residents who will be among the first to see and touch technologies still years away from appearing on the market.

The project is led by researchers at Rutgers, Columbia, and NYU—and in partnership with New York City, Silicon Harlem, City College of New York, and University of Arizona. Within Columbia, it is supported by Columbia Engineering, DSI, Columbia University Information Technology, Facilities and Operations, and the Office of Government and Community Affairs.

Together with an industry consortium, NSF will invest a total of

$100 million

in the next seven years to build four wireless testbeds around the country. Through COSMOS, New York is currently one of only two cities to receive funding (Salt Lake City is the other).