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NYU Wireless
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This experimental license request renews and expands upon propagation measurements at The University of Texas at Austin. Professor Theodore S. Rappaport has recently moved from UT-Austin to New York University (NYU) but will continue these propagation measurements at new geographic locations. The previous license at UT-Austin was file number: 0548-EX-PL-2010, with confirmation number: EL186811, and call sign: WF2XQM. Prof. Rappaport will continue to conduct propagation measurements at 38 GHz and 60 GHz, and, in addition, 28 GHz with 1 GHz RF passband bandwidth at each of these frequencies.

Millimeter Wave communications in frequency bands above 20 GHz are the next frontier of the wireless age. At these frequencies, immense uncompressed data rates are possible (1-10 Gbps). The unprecedented data rates possible at millimeter-wave frequencies are not available in lower frequency bands, which are spectrally crowded due to the rapid expansion of traditional wireless technologies. Several major corporations have already committed resources towards creating products for the unlicensed 60 GHz band, and several short range indoor products are already on the market. Future uses of millimeter wave bands, such as 28 GHz, 38 GHz, and 60 GHz, include vehicle-to-vehicle or base-station to mobile applications in the sub-1 km range.

The physical circuit challenges of operating at these frequencies are important for communication systems, and have been explored extensively for the past decade. However, reliable wireless communication systems must operate in more than a highly controlled laboratory environment. In this context, channel sounding, or channel propagation measurements, are required to provide knowledge that may be used in the proper design of any wireless millimeter wave communication system.

The research group at New York University (NYU) and Polytechnic Institute of NYU (NYU-Poly) possesses one of the few systems in academia capable of performing channel measurements at 28 GHz, 38 GHz, and 60 GHz for a distance of a few hundred meters. Professor Theodore Rappaport, who served on the FCC technological advisory board for several years, has utilized this system previously both indoors and outdoors (See References 1-4). These preliminary investigations received many citations and are currently of great interest to communication system engineers planning millimeter wave radios.

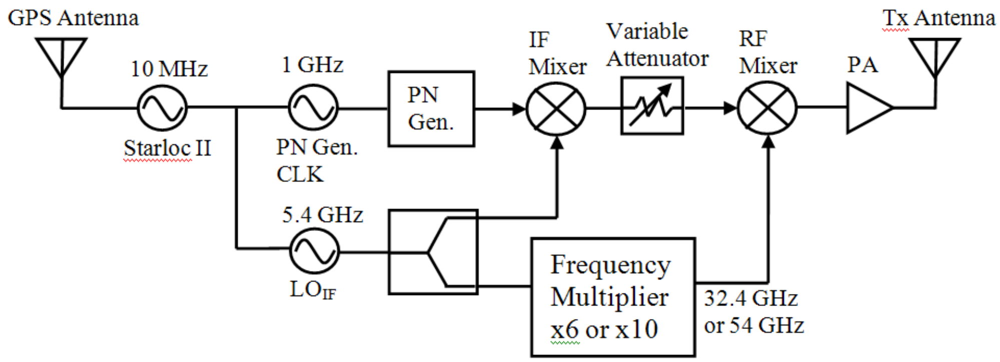
The proposed 24-month project involves outdoor stationary and mobile measurements around NYU and NYU-Poly main campus in Manhattan and Brooklyn, New York, respectively, with transmission range not exceeding this campus area. Various types of measurements will be taken including power delay profiles, angle of arrival, foliage, fog attenuation effects, Doppler shifts, small and large scale fading effects, and co-polarized and cross-polarized links. Such measurements are vital for understanding the link budget, range, and proper spatial frequency re-use distances. The frequency bands that will be investigated are 27.5-28.5 GHz, 35-41 GHz, and 57-63 GHz at a transmission power of +15 dBm nominal and 1W peak power. The transmitted signal is a spread spectrum type with the signal being spread over a bandwidth of 1 GHz. A swept time delay cross-correlator channel sounding technique utilizes the direct sequence spread spectrum signal to perform a wideband measurement. Various directional antennas will be used with gains not exceeding 40 dB. These antennas, built by DBS Microwave, are listed in the table below with their corresponding boresight gains and beamwidths.

Antenna	**Gain (dBi)**	**3dB Beamwidth (degrees)**
U-band Tx Rectangular Horn (60 GHz)	25	6.25
Q-band Tx Sectorial Horn (38 GHz)	19	7.51
Q-band Rx Conical Horn Reflector (38 GHz)	39	16.91
Ka-band Tx Rectangular Horn (28 GHz)	TBD	TBD

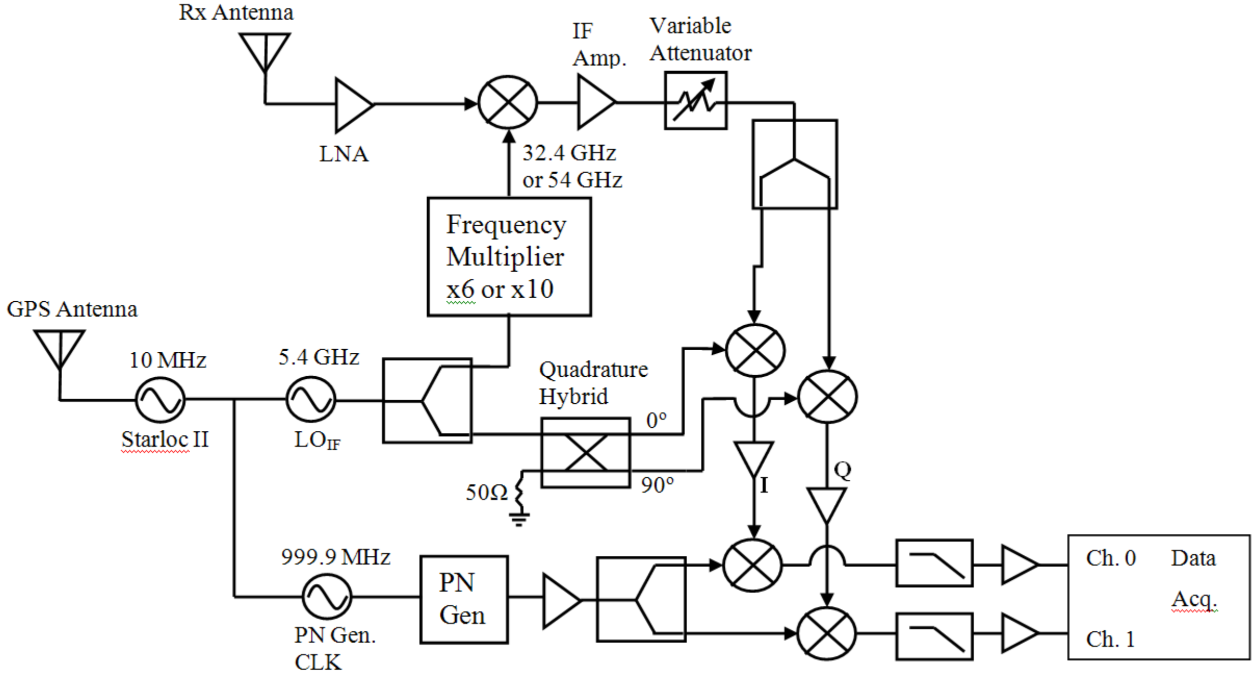
The full system consists of pseudonoise (PN) sequence generators being converted to an intermediate frequency (IF) of 5.4 GHz and then upconverted to the final radio frequency (RF) of 28 GHz, 38 GHz, or 60 GHz. The receiver down converts the signal with the same RF and IF frequencies. An IQ demodulator extracts the in-phase and quadrature components of the signal, in order to collect the phase information of the received signal. Lastly, a correlation operation (multiplication and integration) is performed between the received signal and a time-swept replica of the PN sequence.

Frequency synthesizers are used to generate local oscillators for the up and down conversion mixers, as well as the PN sequence generator clock. These frequencies are all generated from a common reference of 10 MHz provided by Datum's Starloc II GPS-disciplined ovenized oscillator. A diagram of the described system is seen below.

Transmitter



Receiver



Once data is collected, it will be processed and integrated into channel models. This information will be published to assist other researchers and designers in developing advanced communication systems.

References

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3. Xu, H., Rappaport, T.S., Boyle, R.J., Schaffner, J.H., "38-GHz Wide-Band Point-to-Multipoint Measurements Under Different Weather Conditions," *IEEE Communications Letters*, vol.4, no.1, pp.7-8, Jan. 2000.
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