Smart Campus to Smart City: 5G SDN-based Networking for Enhanced Urban Living

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By 2050, 70% of the world population is expected to live in urban environments. This is a big number, one which should spark big thinking in terms of redesigning the role of technology and connectivity in today's cities, addressing current challenges and creating smart and sustainable solutions. We envision addressing the next generation of urban challenges by designing a communication architecture that is interoperable and scalable, leveraging current technology and deployment efforts while being able to provide high-data rate, reliable communications to very large amounts of devices. In particular, we anticipate to meet the requirements of the future wireless city by proposing a Software Defined Network (SDN)-based infrastructure for seamless communications in dense urban environments built on top of a combination of WiFi, LTE and a 5G backhaul on the 60GHz unlicensed band. Beyond high data rate connectivity for citizens on public and private transportation, heterogeneous and dynamic communications enabled by the proposed infrastructure can be used for implementing desirable services that make cities smart, ranging from guided parking, green lighting, multimedia (possibly crowdsourced) monitoring of neighborhoods, traffic, and structures, etc. Its ad hoc nature will also provide resilient backhaul communication in critical situations, when the currently prevailing LTE and WiFi network infrastructure is disrupted or inaccessible.

Our way to smarter cities starts by developing this infrastructure where we work. The Boston campus of Northeastern University (NU) will be endowed with a programmable networking testbed integrating the current WiFi infrastructure with new LTE-A and 5G capabilities providing users with continued high-rate data transfer, supporting mobility as they walk or travel through campus in a bus or other vehicle (Figure 1). The infrastructure should comprise off-the-shelf 60GHz transceivers to be deployed on the NU bus and at fixed locations. This *mobile femtocell* will provide people riding the bus with very high bandwidth Internet access in the mmWave spectrum. Communications would seamlessly fall back to LTE-A or WiFi in spots with no Line-Of-Sight (LOS) 60GHz connections. System integration and programming will be performed by a set of newly-developed cross-layer, platform-independent protocol development abstractions. These will implement the control plane of a newly defined, distributed SDN architecture, running on a centralized NU SDN controller as well as on sub-controllers placed at the network edge to control local resources, facilitate access, measurements as well as provide higher robustness. Networking protocols, algorithms, and transmission schemes will be software-defined but hardware-executed by reconfiguring flexible processing hardware at runtime.

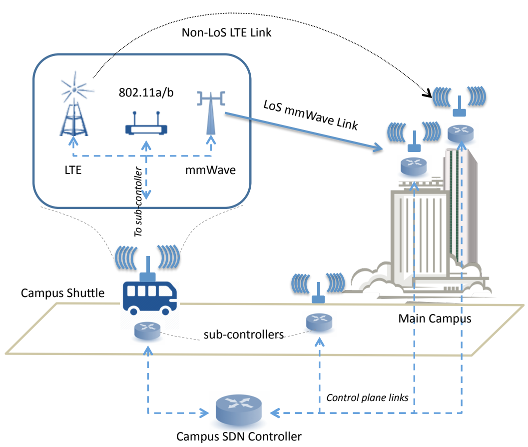

Figure 1: Smart campus testbed.

Background. The challenges to be tackled to design and build a smarter campus require extensive and complementary expertise, ranging from hardware/software co-design, software defined radio and networking, and protocol design, implementation and testing. Our team have significant experience in the field of experimental networking and of software-defined/cognitive radios and networks. Basagni is the PI on an NSF MRI project concerning the construction of a production-quality underwater acoustic network and was also supported by an NSF MRI award focused on developing a multi-purpose wireless sensor networking instrument with interference cancellation capabilities. He will bring to this project his expertise in network protocol design and testing, and in the definition of the new protocol development abstractions. Chowdhury and Leeser have built a series of software defined radio platforms designed to reduce the latency for cognitive and software defined radio by shifting the processing closer to the RF front-end. Their experience gained in the development of these platforms complements the goals of flexibility and expansion capability of our proposed infrastructure. Melodia has received an NSF MRI award that has created an underwater networking testbed with reconfiguration capabilities from the physical to the network layers of the protocol stack. He has also extensive research experience in software-defined radios for cognitive wireless RF networks, and will be contributing to this project his expertise in both hardware and algorithmic co-design.

Funding. Reimbursement of travel expenses of one of the authors would be appreciated.