This thesis contributes a new system in support of large scale people-centric sensing applications. Over the last decade, wireless sensor networking has developed into arguably the most active area in networking research. The state of the art largely follows an application-specific philosophy, where modest numbers of static wirelessly-connected sensor nodes are placed in the target environment in support of a single application. In a properly engineered network, sensor nodes are well-equipped and well-positioned to best provide the connectivity and sensing required by the application. Such networks are illsuited, however, to the demands of a new class of applications focused on providing sensor information about people, their daily lives, and their environments. These people-centric applications require the ability to both sample very detailed information on the individual scale, and to provide a view of the urban landscape - a very large scale challenge. A new approach is required.

Therefore, we propose the novel MetroSense architecture in support of people-centric sensing. While incorporating static infrastructure elements, to get large scale sensing coverage the architecture primarily makes use of devices with embedded sensors, such as mobile phones, that people already carry daily. The architecture adopts an opportunistic paradigm where interactions between mobile sensors and static infrastructure elements occur as allowed by the uncontrolled mobility of people. The power of this architectural choice is that it allows applications to marshal very large numbers of mobile sensors without deploying an extensive static grid dedicated to a particular task. People-centric sensing facilitates statistical spatial and temporal sampling of the field, building up data over time for applications that require this wide area but still detailed view. More importantly, since the sensors are human-carried, they are always where they need to be (geographically) to sample people and their environments.

The people-centric architectural approach is not without its challenges, however. Reliance on a people-powered mobile architecture means that sensing device characteristics will be heterogeneous - different sensor types (e.g., camera, microphone, accelerometer) will be embedded in different devices and these devices will have different storage, processing and communication capabilities. Additionally, sensors will be carried in a manner most convenient to the human (e.g., in a pocket or purse) and not necessarily in a manner most conducive to high fidelity data gathering for an application. Finally, due to the uncontrolled mobility of people, rendezvous among the sensors and the static infrastructure elements may not happen on the time scales best suited to the needs of applications. Together, these challenges embody what we call the sensor availability problem, brought on by resource heterogeneity and reachability limitations; and the sensor context problem, caused by mismatches between the requirements of application queries (e.g., location, body position, angle/orientation, etc.) and actual context of the mobile sensors to which these queries are assigned.

To address these two problems, in this thesis we present Quintet and Halo. Quintet aims to address the sensor availability problem by allowing for the discovery and sharing of sensing resources between devices that rendezvous in situ. Thus, a device assigned a query requiring samples from a sensor it does not have can borrow samples from a nearby device over short-range radio. Such sharing can also take place if the queried

node.s context does not match the sampling context required by the query. Among its contributions, Quintet provides a language for context specification, a method of context analysis and comparison between neighbors, a protocol managing the transfer of sensor data from the sharing devices to the consuming devices, and perhaps most importantly a mechanism for learning the context specification that is most likely to yield higher fidelity data for a particular scenario. Halo addresses the sensor availability problem by providing a mechanism to increase the probability of rendezvous between mobile sensors and static infrastructure elements in an effort to improve the perceived responsiveness of the system to "delay-aware" applications. Halo provides a tunable knob to balance responsiveness in terms of average delay in answering a query on the one hand, and consumption of system resources such as mobile sensor energy and the radio channel on the other hand.

Finally, we present BikeNet, a mobile sensing system for mapping the cyclist experience. Built as an instantiation of the MetroSense architecture to provide insight into the real-world challenges of people-centric sensing, BikeNet uses a number of sensors embedded into a cyclist.s bicycle to gather quantitative data about the cyclist.s rides. BikeNet uses a dual-mode operation for data collection, using opportunistically encountered wireless access points in a delay tolerant fashion by default, and leveraging the cellular data channel of the cyclist.s mobile phone for real-time communication as required. BikeNet also provides a web-based portal for each cyclist to access various representations of her data, and to allow for the sharing of cycling related data (for example, favorite cycling routes) within cycling interest groups, and data of more general interest (for example, pollution data) with the broader community.

To support people-centric applications in the wireless sensor network domain, a new architectural approach is required. The MetroSense architecture allows for urban scale deployment at a relatively low cost compared to existing alternatives using an opportunistic approach. Together, Quintet and Halo provide a set of mechanisms that improve the responsiveness of the network and the quality of data sampled on behalf of applications, serving as a solid foundation for future people-centric sensing networks research.