Toward a statewide public Internet of Things (IoT) network

1952063
K. Max Zhang, Cornell University
IRG, FY2020

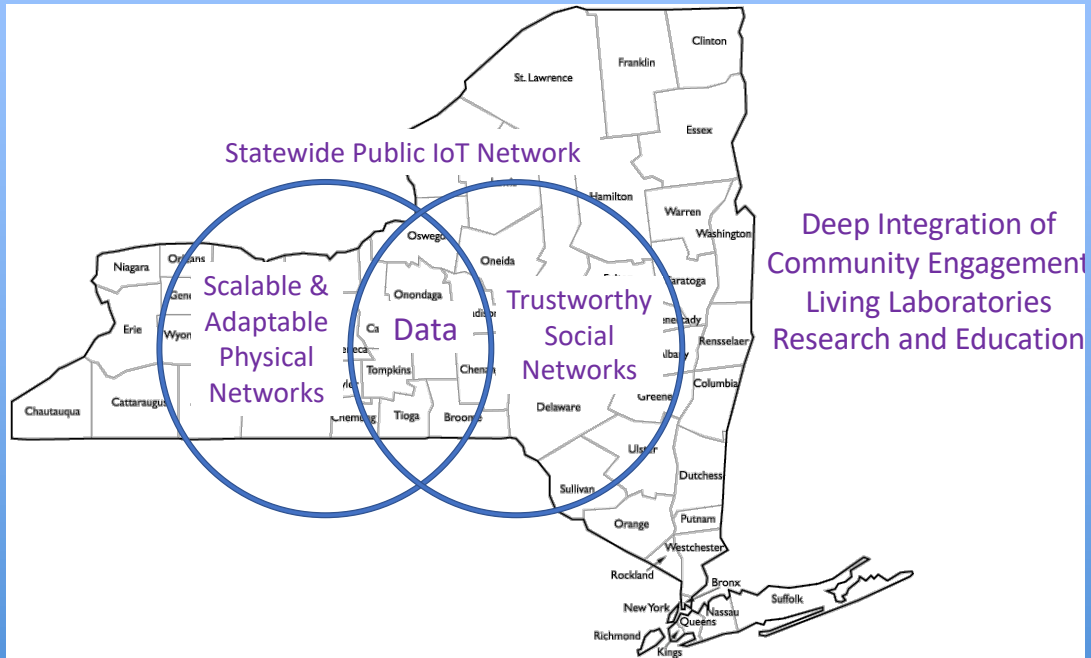| **Principal Research Investigators (Name, Institution)**	**Community Partners (Name, Institution)**
· David Shmoys, Cornell University · Stephen Wicker, Cornell University · Rick Geddes, Cornell University · Lee Humphreys, Cornell University · David Kay, Cornell University	• Kenneth Schlather, Cornell Cooperative Extension (CCE) offices in 62 New York State Counties.

Project Overview

Visual Schematic

Statewide Public IoT Network

Scalable & Adaptable Physical Networks

Data

Trustworthy Social Networks

Deep Integration of Community Engagement Living Laboratories Research and Education

Project Vision

- **Our vision is that municipalities across the New York State operates their own public IoT networks, offering services as basic utility, and those distributed LPWAN-based IoT networks form a statewide network that provides 100% coverage to New York residents and effectively bridges the digital divide.**

- **This project explicitly sees rural communities as opportunities for developing new networked technologies which can leapfrog traditional wired broadband technologies and create new opportunities for local technological development and innovation.**

Project Overview

Use-Inspired Research

- **The project is motivated by an imperative need to bridge the digital divide between rural and urban areas, such as in New York State, which has contributed not only to information disparities, but also greater social, democratic, educational, and economic disparities.**
- **Researchers team up with Cornell Cooperative Extension (CCE) offices in 62 New York State Counties to bridge the digital divide.**

Fundamental Research Contributions

- **Our work on network optimization for 100% LPWAN coverage will greatly advance the algorithmic development for multi-stage decision-making problems, which will find use in many other socially-relevant applications.**
- **The proposed research transforms the field of data security and privacy as security and privacy protection to be built into the network from the beginning, as opposed to being added after the fact.**
- **We expect this project to have a major impact on the fields of economics and infrastructure finance.**

Project Update

Testbed: To adapt our project to the challenges posed by COVID-19, we refocused the proposed testbed development on Tompkins County, home to Cornell University. We are co-designing several IoT applications with community partners on energy, water, poverty, public transportation and healthcare in our local community with broad impact across the country.

Optimization: We have created a framework to develop the proposed scalable and adaptable network topology for 100% LPWAN coverage. Framing it as a multi-stage decision-making problem, we take into account access to current and future broadband infrastructures, LPWAN network technology and geography.
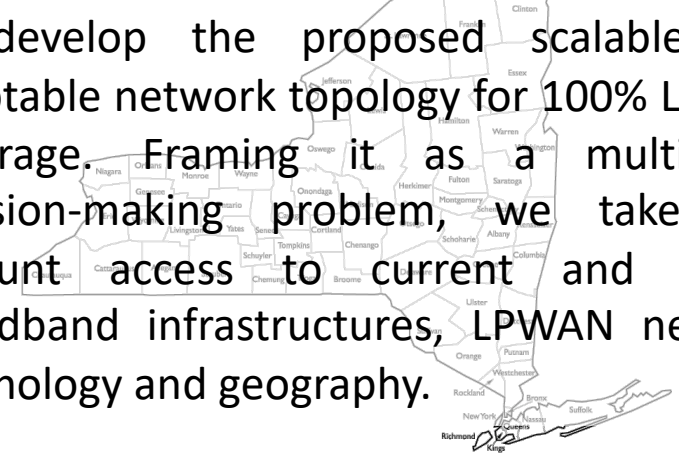
Privacy and Trust: As part of the proposed community-scale, appliance-level energy feedback system, we have successfully incorporated differential privacy and federated learning techniques into the energy disaggregation problem. We will implement those techniques in our network of building managers to test whether they help promote data sharing within the network while protecting data privacy.

Deep integration of research, education and engagement: Enabled by the NSF support, PI Dr. Zhang has integrated three pillars in academic activities, i.e., an externally funded research project (this grant), a course and a student project team, around the theme of public IoT and community engagement.
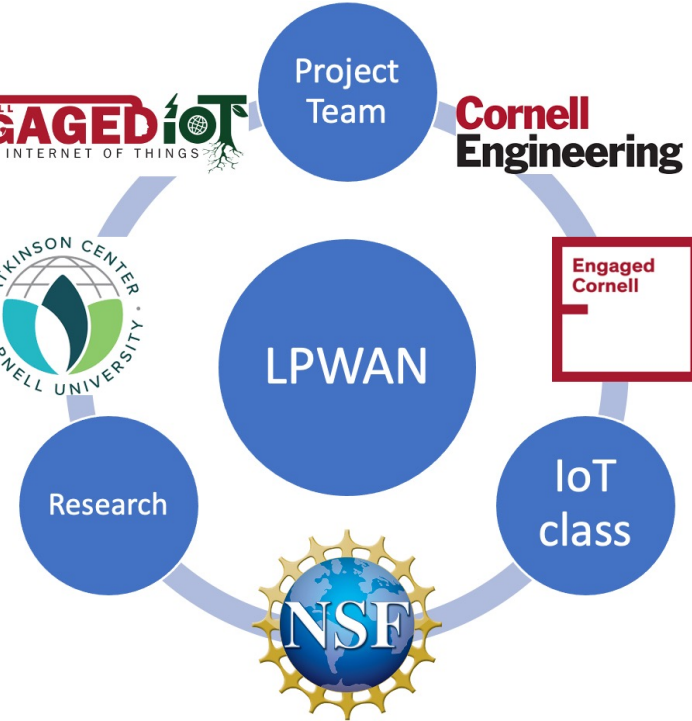
Project Evolution

How have your project activities to-date shaped or evolved the long-term vision of the project? Specifically, we want to understand how engagement with your team (e.g., researchers and community partners) and feedback from the target community is informing your research and pilot activities. Give one or two specific examples.

Examples:

"COVID-19 has posed a significant barrier to creating the proposed public IoT testbeds in three New York municipalities with 100% LPWAN coverage. Working with our community partners, we have adapted our research activities to focus on optimizing the deployment of public IoT networks and creating compelling user cases to demonstrate the benefits of a statewide public IoT network."

"Our lead community partner solicited ideas from communities on socially relevant IoT applications. We mobilized our students to co-design those applications with community partners, addressing challenges in COVID-19, poverty, water, public transportation and healthcare in our local community with broad impact across the country. The co-design efforts have not only made compelling cases for a public IoT network, but also enabled our social scientists to investigate how community members' perception of IoT changes before and after being exposed to it."

Anticipated outcomes & success measures for next year

We expect to deliver a preliminary roadmap for deploying a statewide public IoT network as an interdisciplinary team effort (e.g., network optimization, infrastructure economics and community development). The roadmap will detail the costs, benefits and financial sustainability of the network. We are hoping the roadmap will generate momentum as part of the renewed push to expand broadband access in rural communities.

Our social science team has started interviewing community partners and organized participatory workshops. We expect to gain insight on how to build trust among communities of public IoT networks and then develop strategies to improve the trust.
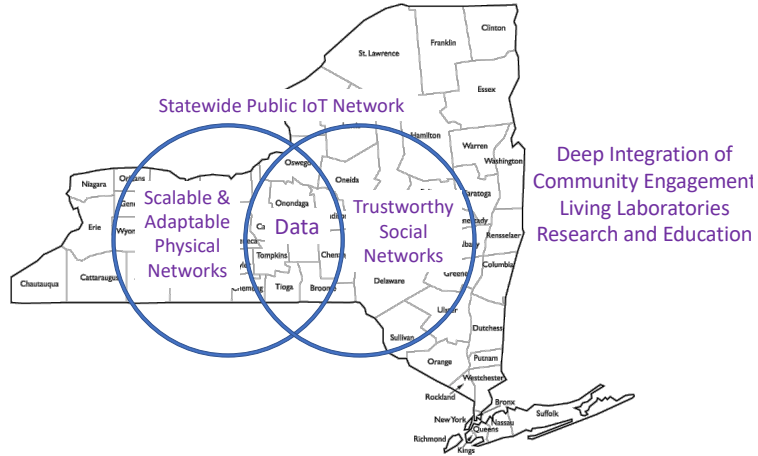
We expect to carry out the proposed testbed development in three types of municipalities (city, town and village).

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Project Vision

Our vision is that, connected through a coordinating entity, municipalities across the New York State operates their own public IoT networks, offering services as basic utility, and those distributed IoT networks form a statewide network that provides 100% coverage to New York residents and effectively bridges the digital divide.

Use-Inspired Research

- The project is motivated by an imperative need to bridge the digital divide between rural and urban areas, such as in New York State, which has contributed not only to information disparities, but also greater social, democratic, educational, and economic disparities.
- Researchers team up with Cornell Cooperative Extension (CCE) offices in 62 New York State Counties to bridge the digital divide.

Fundamental Research Contributions

Our project will make contributions to the algorithmic development for multi-stage decision-making problems, transforms the field of data security and privacy as security and privacy protection to be built into the network from the beginning, and have a major impact on the fields of economics and infrastructure finance.

Please organize the contents of slides (2) and (3) as a quad-chart using the template below. The quad chart should not be included in your lightning talks but should be submitted to NSF S&CC through an upload link that will provided in the coming weeks.