UCLA/Cisco Metropolitan Wi-Fi Research Network

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***Abstract*— We are deploying a metropolitan scale Wi-Fi mesh network near downtown Los Angeles to support the design and development of a data-centric network-fabric for urban participatory sensing.**

Participatory sensing employs software and network technology to enable people's everyday mobile devices to act as credible sensors of the natural, built, and cultural environments. Current research focuses on how to make it easy and secure for both the public and professional users to define sensing 'campaigns,' recruit participants to collect data, to help 'make a case' with data they collect, and digitally publish the results.

To further research in this area, our architecture will enable embedding network–attested location and time context in sensor readings. The network will also provide a research framework for developing policy-based privacy, and related security mechanisms for participatory sensing.

I. Introduction

The mayor of Los Angeles wants citywide wireless access. He proposes a Wi-Fi plan that would provide free or low-cost Internet services over 498 square miles in 2009[1]. Our project explores the potential that a large scale Wi-Fi deployment offers to communities in documenting their own environments, and contributing to healthy and livable cities through participatory sensing.

We are expanding UCLA's urban-sensing network into the community by deploying a metropolitan scale Wi-Fi mesh network in collaboration with California State Parks around the new Los Angeles State Historic Park (LA SHP), a 32-acre site directly adjacent to LA downtown. The network will connect two campus centers and the LA State Historic Park. Figure 1 shows the locations.

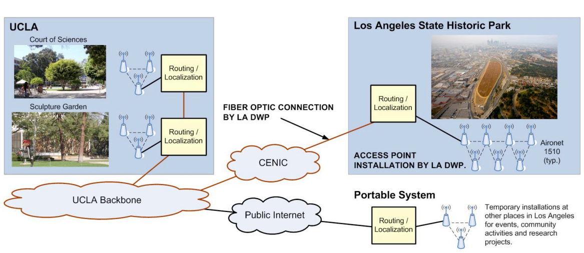

Fig. 1. Met-Wi Locations

The network will also provide a research framework for developing policy-based privacy, and related security mechanisms for participatory sensing, including embedding network–attested location and time in sensor readings. We will perform long–term technology research on how networks can support communities in documenting their own environments as part of creating healthy and livable cities; and collaborative work with local communities that investigates how emerging technologies can be employed to express their identities and histories in today's mediatized society.

II. Network Architecture

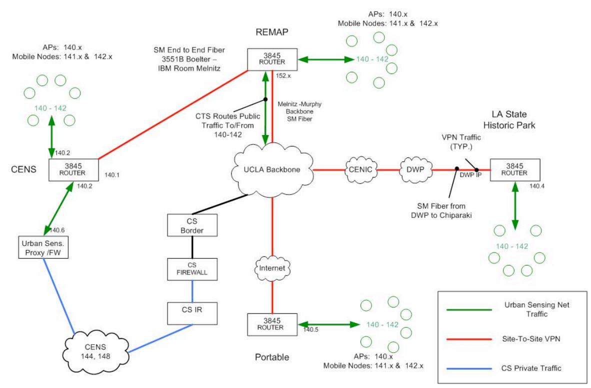

Fig. 2. Architecture

Equipment	Purpose
Cisco Location Appliance 2710	Processes Wi-Fi location data
Cisco Aironet 1510 Mesh AP	Access Points
WLAN Controller 2000 Series	Supports the mesh network
Cisco 3845 Integrated Router	Connect sites & provide VPN & DHCP

TABLE I

Equipment Used in Wi-Fi Mesh Network

Figure 2 presents the architectural layout of the network. We will use five access points to cover each of the UCLA campus sites, six access points to cover the LA SHP and four will be used for a portable system. This is more access points than necessary to cover each of these locations, but we have chosen to do this in order to get better localization information from the system, which is performed using RF Fingerprinting[2]. RF Fingerprinting uses a database of fingerprints of each co-ordinate on the floor-plan of the area being covered. A fingerprint is calculated using signal strength and taking into consideration factors including reflection, attenuation, and multi-path. A clients location is found by querying the fingerprint database with the signal strength reported by all the access-points that can see the client.

At each of our locations only one access point will be connected to the router, this will be the root access point the others will be connected to the root access point in an ad-hoc mesh network. Each access point has two radios a 802.11a radio that will is used as back-haul for the mesh network, and 802.11b radio for clients.

III. Applications

The widescale metropolitan Wi-fi network is an integral tool in the development of various city-wide cultural, social and personal applications. Urban sensing is a new technological advancement that will greatly aid these projects and their completion. Deploying applications for the community motivates research in privacy policy and selective sharing and requires adapting current privacy regulations and guidelines such as the [3],[4], [5], and [6].

A. Campaigns

We have created a campaign model that can be used to formalize many participatory sensing applications. We consider the campaign as a geographically and temporally constrained series of systematic operations to gather a particular type of data–using a network of mobile devices.

In the campaign framework, there are a variety of roles that participants play with regards to a particular campaign (Figure 3).

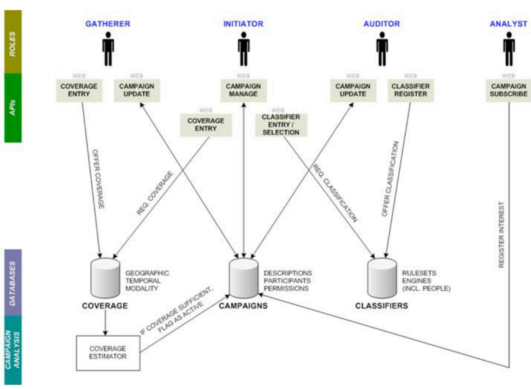

Fig. 3. Campaign Creation

The *gatherers* use geographic and temporal coverage for sampling. They help to classify the data and analyze it in its preliminary form. The *initiator* or campaign manager defines and ensures proper execution. There is also a campaign *auditor* who oversees the general campaign, its execution and creation. Finally, the *analyst* is the one who subscribes to the campaign in order to learn from the data that has been gathered.

In campaign execution the gatherers pass their samples on to distributed analysts who verify and filter through the data. The auditor is then notified of the sample and kept updated with regards to the findings and conclusions that can be drawn from the data.

B. Examples

As one of our first experiments, we have developed a sound level mapping campaign that is aimed at characterizing the amount of noise pollution in and around the LA SHP area. The basic idea behind this campaign is to use Wi-Fi enabled cellphones to gather data samples of an specific durations that will then be uploaded to a central server. This server will determine the decibel level of the sample and associate it with the network–attested time and location from which it was uploaded. This data will then be used to create a 'sound map' of Los Angeles that will in turn, be of great use to urban planners and developers. One application would be to use this as a metric for the quality of life in different parts of the city. The same application can also be used by the community around the park to document the soundscape of their environment.

We are also developing other applications that will allow you to use photographs and video in a similar way.

C. Community Interaction

We are exploring how intermittent georeferenced media records of everyday life can be coordinated to achieve distributed documentation of the urban environment, as well as be fused with other sensed data about the city and fed back into the physical, collective experience in urban public spaces. Unlike scientific applications, the hardware is not owned and managed by a small number of central authorities. Citizens carry sensors and contribute data voluntarily. A single entity does not pose interesting hypotheses, design experiments, force participation. Instead, the process of learning from an urban environment can be organic and decentralized, existing more in the realm of social networking software. However, the power of this network still comes from our ability to verify the context of shared data, to actuate; to aggregate data in space and time; and to allow individuals to coordinate activities.

IV. Conclusion

We have described a metropolitan area Wi-Fi network that we are deploying near downtown Los Angeles. It will enable embedding network–attested location and time in sensor readings for urban-sensing applications. This work will help realize the potential that a large scale Wi-Fi deployment could offer to communities in a multicultural society to document their own environments and create healthy and livable cities through participatory sensing.

V. ACKNOWLEDGEMENTS

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