Cell phone signals could provide bird's-eye view of crises and emergency response

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Someday, emergency response teams handling a crisis like Hurricane Katrina, or even a major traffic jam, may coordinate their responses using a system that projects a bird's-eye view of human movement by tracking cell phone signals via computer.

In the case of a hurricane like Katrina, a WIPER system, as its University of Notre Dame inventors have named it, might assure emergency personnel that a city's evacuation is moving smoothly, or pinpoint where movement has broken down. It might identify that large groups of evacuees are stranded, as was the case after Katrina.

WIPER is engaging undergraduate, graduate and postdoctoral students of Notre Dame physicist Albert-László Barabási; computer science and engineering professor Greg Madey, and sociologist David Hachen. It is funded by a three-year grant from a National Science Foundation program to develop dynamic data driven application systems. (WIPER stands for wireless phone-based emergency response system. The project is explained in detail at nd.edu/~dddas .)

In a Notre Dame research environment that favors interdisciplinary solutions, WIPER provides another bird's-eye view, that of the serendipitous way researchers from different disciplines form collaborations.

In this case, a monthly lunch group on technology-inspired research and scholarship, started by political scientist James McAdams, brought

together Barabási, Madey and Hachen.

“By introducing us to each other, it allowed us to be ready once the opportunity arose,” Barabási said.

Barabási and his research team study networks of many sorts — from the World Wide Web to the behaviors of cancer cells — as they seek a unified theory of networks.

A European cell phone company realized Barabási’s techniques could be applied to understand how people use cell phones, and they provided him with user call and text records collated by customer data on gender, age and postal code. (Because such data is highly confidential, the research team has taken many precautions to protect the identity of callers. All the cell phone numbers are encrypted, and the content of the calls or text messages is not available.)

As Hachen notes, “The purpose of this research is not to identify and track specific users but to analyze patterns and trends among groups of users.”

With the NSF project in mind, Barabási asked Madey to collaborate on creating a simulation tool that could access cell phone usage data in real time. Coming up with the useful concept was up to them.

“We were thinking about people trapped in the (Louisiana) Superdome after Katrina,” Madey recalls. “Every one of those people who have a cell phone is effectively a sensor telling us where the population is. We could get a picture of where the people are, where they’re going, where they’re concentrated. Are they trapped? Is there gridlock?”

An NSF representative recommended that the project include a sociologist whose analysis of social networks could help identify

anomalies in cell phone usage. Hachen already was practiced at studying patterns in human movement such as job mobility – why people leave or stay at their jobs.

In this case, usage patterns examined by age, gender and residential location signal social networks and how people use their phones to interact with those networks.

In exploring what is normal, Hachen's insights also can be of use to the engineers on the project who are devising a system to detect what is not normal.

"The idea is that a sudden, significant deviation from normal calling patterns, concentrated in a particular location, would indicate something out of the ordinary was happening there," he explained.

Madey's team has "curated" the data, while making sure it has remained secure as the project develops. They, too, are developing WIPER simulations that can be demonstrated to NSF.

"At the end," Barabási said, "a common challenge that excites all of us is: How can one use the huge amount of data collected by cell phone providers to understand human dynamics? That is a challenge that will be around for many years, if not decades."

The excitement is shared by more than just Barabási, Madey and Hachen. The project has provided opportunities for undergraduate, graduate and postdoctoral researchers in each division. Madey alone has two graduate students building their dissertations on the project. It's the gift, he chuckles, that keeps on giving.

Source: University of Notre Dame