

Cellphone Data Track Our Migration Patterns

BY ROBERT LEE HOTZ

Cellphone users are spiders of the electromagnetic spectrum, spinning intricate, invisible threads of data about themselves as they walk and talk throughout the day.

Physicists, urban planners and social scientists are eagerly weaving millions of these electronic threads into patterns of people on the move, through studies that until now were all but impossible.

Unable to track human migrations accurately, researchers investigating travel had to make do with indirect measures of mobility. For example, they monitored the movement of bank notes from person to person through online sites such as the United States Currency Tracking Project's Where's George?

That's rapidly changing. More than 3.3 billion wireless-phone subscribers world-wide have, in effect, voluntarily adopted devices that record their daily movements in the same way satellite sensors monitor migrating birds, whales, bears and other wildlife. Such precise positioning data, automatically collected by cellphone companies, makes privacy advocates queasy but has social scientists dazzled by the research possibilities.

Precise data on the sweep of human movements could aid emergency relief efforts in natural disasters, as well as improve urban planning, public transportation and traffic control. It could also help public-health experts better understand the crowd dynamics of epi-

demic diseases.

"What has changed is that we are being tracked on a daily basis no matter what we do," said network physicist Albert-Laszlo Barabasi at Northeastern University in Boston. "Everything we do leaves an electronic fingerprint somewhere."

In the current issue of *Nature*, Dr. Barabasi and his colleagues report on the physics of commuting, using six months of cellphone-company data to track the seemingly random movements of 100,000 anonymous European mobile-phone users. By analyzing more than 16 million records of call date, time and position, the researchers distilled these diverse travel routines into a mathematical pattern, like those previously observed among some predators.

"It is not an overstatement to say these tools are fostering a whole new type of social science," the editors of *Nature* wrote in an accompanying editorial.

Researchers at Massachusetts Institute of Technology are using international data flows of cellphone talk and Internet traffic to capture the complex social dynamics of urban life and globalization. Most recently, the researchers used anonymous real-time data supplied by AT&T Inc. on phone calls, web-browsing and email traffic to and from millions of New Yorkers to chart the city's global social networks. The resulting maps, called the New York Talk Exchange, were recently exhibited at the Museum of Modern Art.

"We are looking inside the city it-

The World According to Flushing

Researchers are analyzing cellular call data to determine how people around the world are connected—a kind of snapshot of globalization. New York's Flushing Queens neighborhood, for example, where more than half of residents are foreign-born, has close ties with South Korea, China and Vietnam. Here are the top 100 cities where AT&T wireless calls were made and received last October between Flushing and the rest of the world, using data from the New York Talk Exchange.



self to see how the global flows can change the minute structure of the city," said urban technologist Carlo Ratti, director of the MIT SENSEable City Laboratory. "You can take information from the cellphone network and see how the city lives and how it moves. It's a bit like globalization in real time."

This dynamic geography of conversation revealed the rhythms of New York's relationships to more than 200 countries. Not surprisingly, communication between Manhattan and the world surges every morning just after the New York Stock Exchange opens, the researchers found. The city most dialed from Manhattan is London, fol-

lowed by Santo Domingo in the Dominican Republic. From Flushing in the borough of Queens, almost 12% of all electronic traffic went to Seoul in South Korea, and 9% went to Porto, Portugal, they said.

Using anonymous mobile-phone data provided by wireless providers, the MIT researchers also have created real-time electronic maps of cellphone use and crowd movements in Rome, Milan and the metropolitan area of Graz, Austria.

In Rome, the MIT group combined cellphone data provided by Telecom Italia with wireless positioning data from buses and taxis across the city to monitor traffic jams and track crowds

at major events, such as World Cup soccer matches and rock concerts.

Both research teams emphasized that they had no way to identify anyone whose calling habits they had analyzed. At Northeastern University, scientists said they studied callers selected at random from six million anonymous mobile-phone customers of an unnamed European wireless carrier. At MIT, researchers said AT&T had provided telecommunications data for the New York project at a network level stripped of any identifiers.

"It can have very big privacy implications," Dr. Ratti said, "but we take the data at such a high level that at no point could there be a privacy problem."