Location, Context, and Mobile Services

The Vision

In order to provide new intelligent services that can enhance our everyday lives, systems will have to take into account the innumerable situational contexts in which we find ourselves. Through various projects, prototypes, and studies, Nokia is exploring the opportunities and issues surrounding rich, context-based services that promise to change mobility and society in ways we're only beginning to imagine.

Context is King

If you ask a friend if she would like something to eat, she'll probably know whether you're talking about breakfast, lunch, or dinner based on the time of day. If you asked an Internet search engine for recommendations about nearby restaurants, however, it might return results for a variety of places to eat, including pastry shops, fast-food restaurants, or five-star eateries, no matter when you happen to be looking. This is because, unlike your friend, a computer needs to be told explicitly about the context of a given question before it can provide intelligent answers.

The problem is that gathering, organizing, and processing all the contextual data that could exist for any situation is a monumental task. There are many pieces of information that might be important, and much of it is simply unavailable to the computer systems currently in place. Even if that contextual data could be obtained more readily, intelligent analysis of such an enormous amount of data is still a significant challenge.

This is where the mobile phone becomes a vital tool in helping to gather, manage, and process contextual information. It is, after all, a powerful computer we carry with us wherever we go. In the near future, it will become a device that can help sense the world around us and assist in transferring and analyzing information. That's the vision behind the current efforts of the Nokia Research Center (NRC) in the field of rich context modeling—the centerpiece of an ongoing strategy for better, more intelligent mobile user interfaces.

Location, Location, Location

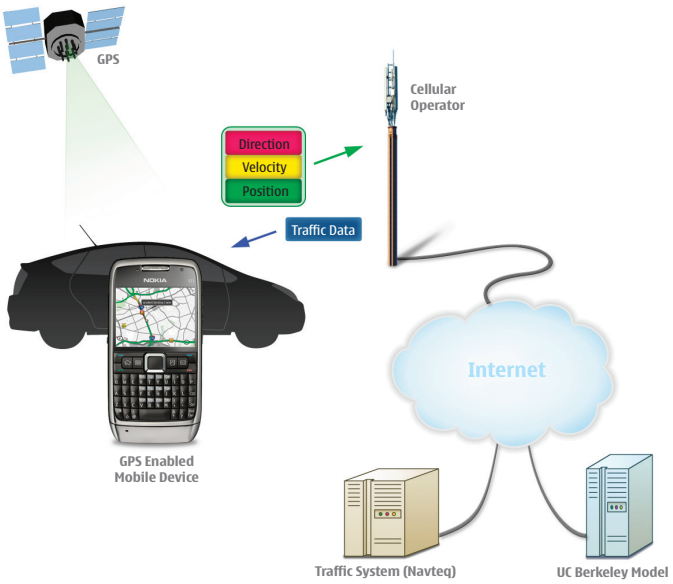
One of the pieces of information that has the most potential is location. That's because, once this is known, there are so many other pieces of data that can be inferred contextually. The weather we're experiencing, for example. Also, the traffic we're in; the language we're speaking; the price we're paying for gasoline; the nearest police station, cafe, park, or hospital; where we were two minutes ago and therefore in what direction we're traveling; even, in many cases (theaters, churches, libraries, stores, airports), what we're doing. Putting all this together, location-aware applications and services hold the key to providing next-generation services that can save us all a great deal of time, money, and peace of mind.

Context is at the heart of the Nokia strategy

Next-generation, context-rich information will enhance many of the services that Nokia offers. If a service can detect where a mobile phone and its owner are located, when the phone is being used, and why, it will have a greater ability to assist with everyday tasks.

Community-enhanced traffic

Researchers from Nokia and UC Berkeley have constructed an innovative traffic-monitoring system capable of fusing GPS data from cell phones with data from existing traffic sensors. The research and development phase of this project, dubbed *Mobile Millennium* for the thousands of early adopters who could participate in the pilot, was deployed in early November 2008.



The Work

Computer scientists have been working on context awareness for many years. Although significant progress has been made in the area of traditional artificial intelligence, much of the work has not come to fruition. Nokia is taking a new approach to the analysis and processing of contextual data by avoiding many of the pitfalls that have ensnared prior work; specifically, downplaying concepts such as ontology and tagging, and embracing a more observational and statistical approach to context modeling.

Nokoscope

The Nokoscope project at NRC started in 2007, and is designed to efficiently capture, store, index, and serve social, spatial, and temporal data. In other words, it records where you are, what you're doing, who you're doing it with, and when. Does this sound a bit intimidating and maybe too intrusive? This is why privacy is a core component of Nokoscope. It protects the data it records, and comes with built-in privacy controls that allows users precise control over what information is shared and with whom.

By recording large quantities of personal data, the vision of researchers is that it will eventually allow services to better adapt to their users by analyzing their actual behavior in the real world, rather than relying on surveys or guesswork. However, managing this massive quantity of data is no small task. Nokoscope is designed to scale from a single server to a server cluster using custom databases, with indices for fast queries that allow aggregation and analysis of the vast amounts of dynamic context, sensor, and behavioral data gathered.

The end result will be more intelligent mobile clients, web interfaces, widgets, desktop applications, and services that allow for microblogging (including "picoblogging," sensor logging, context logging, and so on) and mashups that remix this data with external sources and services.

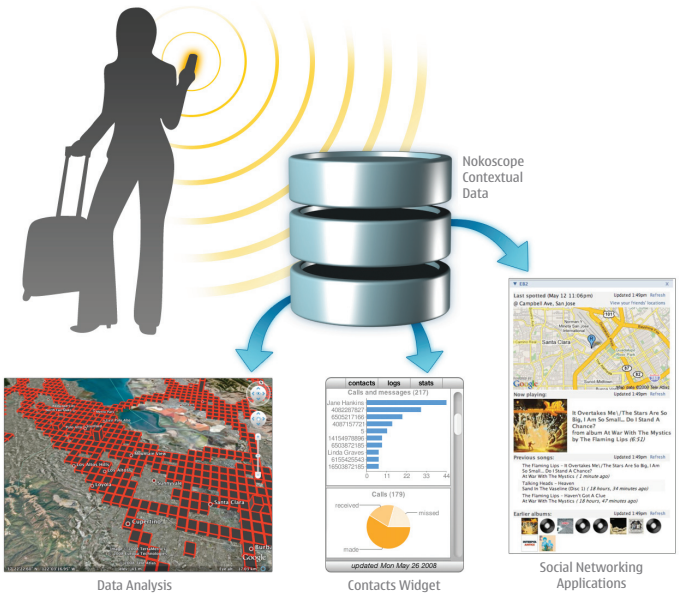
Indoor Positioning

Though location is a vital piece of the contextual puzzle, current GPS technologies have a significant Achilles' heel: They don't work well in the structures in which we find ourselves every day, such as offices, shopping malls, hospitals, and schools. Studies have found that 80 percent of our time is spent indoors. Being able to find friends or relatives in a sports stadium, for example, can save time and ease frustrations. For critical services such as law enforcement, fire departments, emergency personnel, or simply ordinary businesses, effectiveness often involves knowing immediately where people and resources are inside buildings and other complexes.

There are already several custom commercial solutions to this problem, but Nokia is working on ways to provide accurate indoor positioning using readily available infrastructures such as Wi-Fi hotspots and mobile clients. Our work with standards bodies to create open APIs will enable much more rapid rollout of these compelling services without the high cost and effort of current systems.

Simplifying the power of context

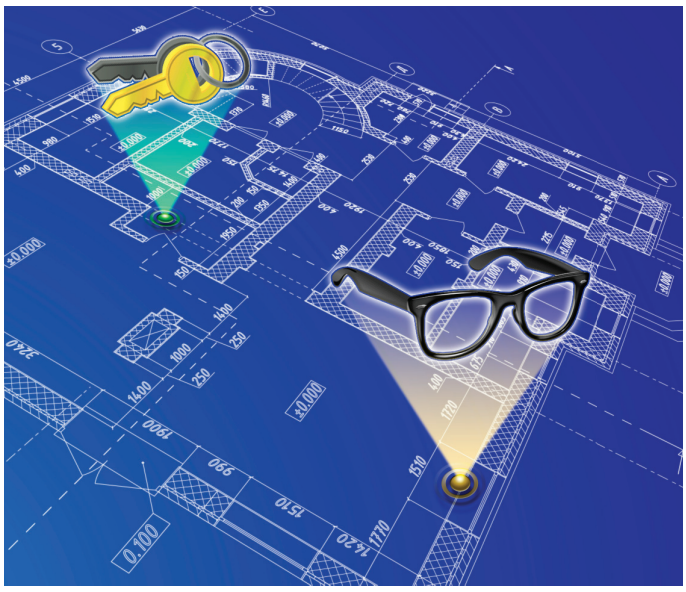
Developers will often have great ideas for using contextual data, but are daunted by the complexity of capturing and analyzing data from mobile devices. The Nokoscope project aims to simplify the process by enabling mobile mashups that let developers tap into contextual data processed by the Nokoscope servers. This will allow adaptive applications, real-time social science, or simply the enhancement of widgets or microblogging through the power of context.



Where are my keys?

Local positioning technology developed by Nokia makes mobile phones aware of the direction of and distance to nearby wireless-enabled devices—including low-power RFID tags attached to eyeglasses, keys, and other easily misplaced objects.

With GPS, any spot on earth can be found. Soon our misplaced keys may be, too, thanks to ubiquitous miniaturized receivers and compact direction-finding antennas in our mobile phones.



Friend View

One of the first examples of using both location and context in an application is an experimental Nokia research project called Friend View. Created by NRC's Solutions Integration team, it's a location-based service that lets people share their movements, moods, and messages. This data is placed on a world map from their mobile device, as well as from the desktop using a web browser.

Friend View builds on traditional social networking by promoting in-person meet-ups, and can help family, friends, and colleagues stay in touch by tracking each other's locations throughout the day. It's both fun and useful—for instance, you can find out easily who is around and available for coffee. And if friends and family are far away, knowing where they on the map helps you feel closer to them, wherever they are.

The backbone of sharing with Friend View is the simple message and location update functionality—a combination of microblogging and location-based services. Users can post updates for all their friends in Friend View to see, whenever they feel like sharing something. They can also let their friends know where they are or where they plan to be, allowing random meetings to occur. Users can also post comments in response to each other's posts and locations, creating fun and interesting threads.

Visual Navigation

Another project at NRC explores using the mobile phone for navigation by enhancing GPS location data with images of landmarks. This creates a 3D representation of the real world that can be used for directions and context-rich exploration of the environment. The resulting augmented-reality interface provides a more intuitive way to navigate, as well as providing easy access to additional information about the world around the user.

Studies have shown that landmark-based navigation instructions provide significant benefits over map and distance-and-turn based directions. They are easier to follow, shorten the travel time, and reduce confusion by providing visual feedback to the user as to whether or not they've chosen the right way to go. By using a lightweight application that can be installed on mobile phones, users are able to see a greatly enhanced world through the phone's camera, with landmarks and directional information overlaid on top of the surrounding environment in full 3D.

A related project available to the public now is Nokia Point&Find, one of the company's first forays into the world of augmented reality. Using the custom mobile client for S60 phones, Point&Find users simply point their camera phone at their surroundings to access relevant information from the Internet.

Though the concepts are simple to understand, behind the scenes of both projects is a constantly evolving database of geolocated images and associated data. Proper selection, recognition, and contextual awareness of the captured images is made possible by the use of image matching and 3D registration of images using robust systems that have been designed to surface data quickly.

Keeping track of friends

Nokia Friend View is a GPS-enabled prototype that helps friends track, text, and meet with each other and share contacts, media, and social interests in real time. Nokia Friend View is available at http://friendview.nokia.com.

Mobile augmented reality

As a sophisticated platform for annotating real-world views and visible objects, mobile augmented reality integrates phone cameras with GPS (for positioning) and onboard sensors such as multi-axis accelerometers indicating orientation and tilt-compensated compasses for heading. Applications can then annotate the user's surroundings by overlaying text and graphics—about nearby sites, restaurants, and so forth—onto the continuous image stream captured by the camera's viewfinder.

The Upshot

Over the next few years, the ways that people record, use, and communicate their personal data, including their location, will multiply and evolve. Mobile phones will continue to become more powerful and add features, GPS will continue to be used extensively outside of buildings, and indoor positioning will become more common. We will be generating an increasing amount of data as our mobile phones add additional sensors and are made to convey more information about ourselves to the cloud. The end result is that this data will be used to provide better, more intelligent services by understanding the context in which we use them, dramatically enhancing our daily lives.

Privacy and Georights

Sadly, the constantly increasing levels of innocuous spam email and more serious crimes of identity theft have been clear indicators of the baser instincts of some to abuse the privacy of others. The near future may see a strong counterreaction to data visibility and sharing. In fact, Nokia believes that the spread of technologies such as always-on location-based services will happen relatively quickly; negotiating location rights and permissions and maintaining levels of privacy will prove trickier and take more time.

There is no clear solution to the problems of privacy and "data leakage," because there are significant hurdles to making all personal data anonymous. A real strategy is to educate consumers more about the information trail they are creating as they use new services. Another is for corporations to commit to pro-consumer standards and practices when handling their customers' data. Some work has begun in these areas, but much more is needed. Just as e-commerce was at first distrusted by consumers, but then adopted as familiarity with the concepts and security improved, privacy issues and controls will likely follow a similar path to acceptance and become more commonplace for end users as time goes by.

Potential

We have just begun to scratch the surface of the possible applications for contextually aware services. Think of your mobile phone as your digital companion, constantly watching over the world around you, looking for ways to help. As more of the data it captures is integrated with Internet-based services, there will be more potential for those services to be truly helpful in your everyday activities.

Your mobile phone contains important pieces of personal data, including your contacts, photos, music, games and location. In the future it will be able to record even more information including altitude, temperature or other nearby phones. But as useful as all that data is, by analyzing and aggregating it over time, services will be able to predict and infer even more valuable information that can be used to create even more helpful services in the future. This is the technology that many have been dreaming about since the inception of the modern computer age: Systems that empower people by predicting needs based on their activities and providing information when and where it is required, all as a normal part of everyday life.

For further reading

Publications:

Personal Content Experience: Managing Digital Life in the Mobile Age, Juha Lehikoinen, Antti Aaltonen, Pertti Huuskonen, and Ilkka Salminen. John Wiley & Sons, June 2007.

"Augmented Reality: A New Way of Seeing," Feiner, S. K. Scientific American, April 2002.

"Empty Seats Traveling: Next-generation ridesharing and its potential to mitigate traffic and emission problems in the 21st century" Hartwig, Stephan; Buchmann, Michael. February, 2007.
http://research.nokia.com/files/NRC-TR-2007-003.pdf

"Architectural Solutions for Mobile RFID Services on Internet of Things" Michael, Martin Peter; Darianian, Mohsen. April, 2008.
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"Outdoors Augmented Reality on Mobile Phone using Loxel-Based Visual Feature Organization", G. Takacs; V. Chandrasekhar; N. Gelfand; Y. Xiong; W-C. Chen; T. Bismpigiannis; R. Grzeszczuk; K. Pulli; B. Girod. ACM International Conference on Multimedia Information Retrieval (MIR'08), (2008)
http://people.csail.mit.edu/kapu/papers/mar_mir08.pdf

Websites:

Nokia Research: http://research.nokia.com

Nokia Point&Find: http://www.nokia.com/pointandfind

Nokia Friend View: http://friendview.nokia.com

Nokia Indoor Positioning: http://www.nokia.com/A41229024

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