# Safe & Sound: a wireless leash

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**ABSTRACT**

Safe & Sound uses location-aware mobile phones to create a "virtual leash"; a secure zone beyond which a child may not travel. If the child leaves this zone, both child and parent receive audible alerts, and the parent can communicate with the child by voice over the phone. The peer-to-peer transmission of location, and the accepted role of responsibility by care-givers, reduce the privacy concerns which often arise with location-aware systems.

**Keywords**

mobile computing, location-awareness

## INTRODUCTION

*scenario: Little Ben wants to ride his tricycle in the park before going home. Mom agrees, checks that Ben's cell-phone is on, and reminds him not to go too far or his phone will start to beep. Mom sits down to read the newspaper. Little Ben rides around within a "safe range". At some point he sees a cute dog and starts to wander off after it. Both his and mom's phone start to beep. The child realizes he has gone beyond bounds but decides to follow the dog anyway. Mom places a call to her child to find out where he is and negotiate a permissible radius.*

**Fig. 1.** Safe & Sound hardware is in little pouch on the tricycle handle-bars.

**Safe & Sound** (figure 1) is a location-based information system that allows parents to monitor their children's location. The child's phone continuously streams location information to the parent's phone. A voice channel between the parent and child enables negotiating with, and perhaps educating of, the child. As the title of the project implies, we emphasize both security and communication for this solution to a common parental concern.

Although there is a growing body of location-aware mobile services, Safe & Sound occupies a relatively unexplored aspect of such systems. Location-based information systems can be largely categorized into three groups, based on the type of information they provide, and where or when the information is triggered:



*CHI 2003*, April 5–10, 2003, Ft. Lauderdale, Florida, USA.

ACM 1-58113-630-7/03/0004.

- public information at absolute locations

The user must reveal his location to a service in order to receive the information. This is done either by constant monitoring to enable the system to push the information, or by query from the user at a certain location, in order to pull the information. Such systems [1] often raise issues of privacy and questions such as: whom can do what with the information. An exception being emergency services, for which we don't mind revealing this sensitive information. People will generally reveal some location data if in exchange they receive valuable and relevant information. However location-based spam would surely be a nightmare.

- personal information at absolute locations

In such systems the absolute locations are a set of latitudes and longitudes that make sense only to the user. Both the locations and the information triggered are personal and user-depend [2]. With the correct architecture, this type of system can be safe, and no external database is required. The user can reveal his virtual location to others without it fixing him to an absolute latitude/longitude; "my bookstore" could be any of the numerous bookstores in Cambridge or Boston. There is a difference between sharing information with a database and with another person, and it is essential to have the proper level of abstraction.

- personal information at relative locations

Safe & Sound fits into this category. The absolute location in this case is less important than the relative one. The location can be relative to a fixed point or to a mobile one. Private information (i.e. the exact geographic location) is not revealed to anyone else besides the parent. Because the relationship between a parent and a child is asymmetric, privacy is less of an issue. In care giving situations people are usually willing to relax their privacy demands, so systems for small children, or perhaps elderly parents, can be more lenient in this respect.

## ARCHITECTURE AND IMPLEMENTATION

Safe & Sound is a wireless "leash" for children. It permits the child to have a little more freedom while giving the parent awareness of the child's location. The application enables a parent to define a secure zone –an area in which the parent considers the child to be safe. It can be defined as a radius around a fixed point, or around a moving target. For example in the two following scenarios:

- Your five year old child is allowed to ride his bicycle around the block, but not to go any further. In this case the secure zone is defined as a radius around your house.

- A parent takes her kid to an amusement park, but wants the child to remain within a certain proximity. In this case the safe zone would be defined as a radius around the parent. (more specifically a radius around her phone)

If the child ventures out of this zone, both the parent and the child will receive a sound alert.

Such a system requires: a communication channel, an alerting mechanism, and location-awareness. The communication channel enables the parent to talk, and perhaps scold, the child. With an older child, a parent may decide to negotiate a larger range or perhaps a change of plan. The audible alerting is useful in real-world hand/eyes busy situations; the child may be riding his scooter, and mom may be driving or washing dishes.

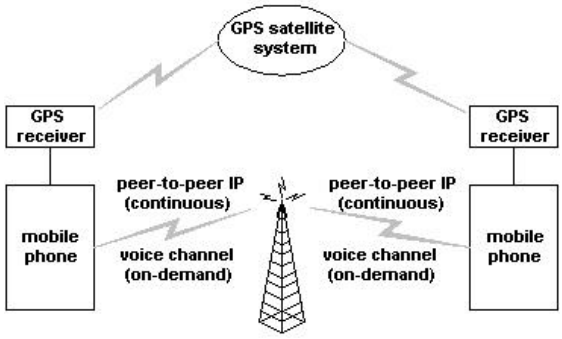


**Fig. 2.** Architecture of the Safe & Sound system.

Location can be absolute or relative to another location. There are a number of advantages to absolute location; for example, the child can cycle around the block while the parent runs an errand or is at work, and the parent will still be notified if the kid goes out of the defined range. Relative location awareness could be done easily using a radio transmitter and receiver; the child could carry the radio transmitter and the signal strength could be measured from the parent's receiver. However this scheme has limitations: it requires the parent to be in range of the child, not permitting the parent to, for example, run an errand at the same time. Moreover, once the child has gone out of range, it is very difficult to track his location, and such a system is not very extensible. Typically systems that depend on signal strength to measure distance are limited to fairly small ranges, they are sensitive to the composition of the environment (e.g. walls vs. outdoors), and the only configuration they support is a radius distance (as opposed to a polygon).

This project was implemented on Motorola iDEN Java-enabled phones. Mobile phones are appropriate for this application not only because they are ubiquitous but also because they provide a voice channel. The system requires two Java-enabled mobile phones: one for the parent and the other for the child. Location is received from a GPS receiver attached to the serial port, or built-in (i88s), to the phone (figure 2). An alterative to GPS would be to get the position information from the network –they are required to have this for emergency calls. We prefer the peer-to-peer protocol we have used here, because it doesn't raise as many privacy concerns.

A Java application on the parent's phone enables the parent to determine the secure zone radius and center. The zone radius could be, for example, 70 meters. The secure zone center is either a fixed location (latitude/longitude) or the parent's phone. One can also set the data frequency, that is, how often the GPS coordinates of the child's phone will be sent –the default is 2 seconds. Additionally, the GPS coordinates can be logged if the child exits the secure zone. This could be useful for finding the child in extreme cases.

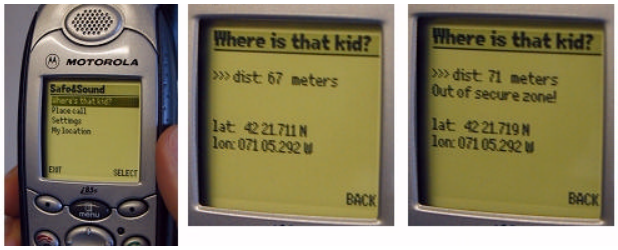


**Fig. 3.** When the child leaves the secure zone, an audible alert sounds on both phones.

The data exchange between the phones is continuous peer-to-peer IP in the form of UDP packets containing position information. If the child goes out of the defined radius, both the child and parent receive a sound alert. The parent can see on the phone display how far away the child is and the latitude/longitude coordinates (figure 3). If the child continues to go further away, the parent may choose to place a call to his phone by selecting this option from the main menu.

## FUTURE WORK

Features we would like to include in the next prototype include a location aid to assist the parent in finding the child. This would include a compass display and directions the parent should follow. Most handheld GPS receivers provide a similar user interface to follow a route or track back to a known location.

Instead of the safety zone being a circle around a certain point, whether relative or absolute, we would like it to be an area defined by a polygon. The system should be able to store several different polygon definitions and they should be shareable. A parent could walk around the block and Safe & Sound could use this route location data to define the safe area. Another parent could, for example, stake out the polygon around the mall and share it with his neighbours. An older child might be allowed to hang out with her friends at the mall as long as she didn't leave that area.

## REFERENCES

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