

# Human Tracking Devices: the Active Badge/Bat and Digital Angel / Verichip systems

## Active Badge, Active Bat

Information technology and ubiquitous computing is a very important subject in our era. We are highly advancing toward newer technologies which enable us to transfer data from one point to another relatively cheap compared to few years earlier. This has raised the expectation of our society to be able to receive or send data for a subject at any given time.

Active Badge and Active Bat, are just a few examples of how ubiquitous computing has come to play into our daily lives. And these two topics are going to be discussed in this paper.

Before getting into detail of how these mentions technologies work, communication systems will be briefly discussed.

There are three types of communications systems:

1. Transmit only
2. Receive only
3. Transponding

Transmit only: as the name specifies these are the devices that can only send signal/data. In other words they can only communicate one way with a system. The system cannot send any signal back to the device.

Receive only: are devices/ systems that can only receive data from other devices. Many simple communication devices are made of a combination of transmit only devices coupled with receive only devices. There are many applications where there is no need the two devices to be communicating in both directions, hence they use transmit only and receive only devices.

Transponding: a device that can both transmit and receive signal from other devices.

### **Active Badge**

Active badge was originally developed from 1989-1992 at AT&T labs. Active badge makes it possible to locate any person at any given time with an acceptable accuracy. This device uses infrared technology (IR) to transmit data. The advantage of IR solid state emitters is the ability to produce them very small and very cheap.

Every badge has an IR emitter which sends a unique pulse signal every specified time interval. In every room of the building there is are sensors that can detect the signals coming from these badges. Since IR reflects off the walls therefore the signals are confined in only one room making it possible to locate badges. Since infrared also bounces off other objects in a room, it is possible for the sensors in the room to receive the signal without having to be exactly aligned with the infrared emitters.

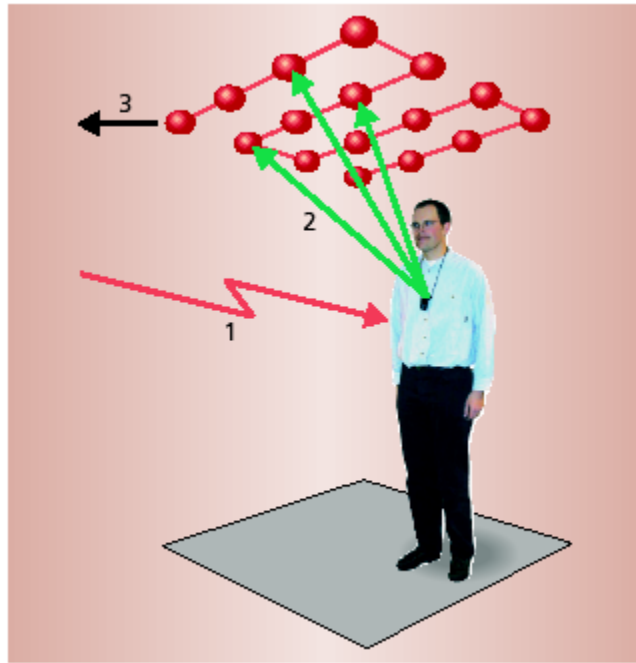
This device works using a property of IR which is bounded by the physical wall. Infrared bounces back off walls and other materials in the room. Therefore by having sensor(s) in every room that can pick up signals sent by the badge, the location of a specific sensor can be determined within an office.

Although Active Badge is a very useful device in many office buildings, it is practically useless in a factory or in an office where there are no confined rooms. For example, active badges are basically nonfunctional in an office covered with cubicles. Since these devices function properly in a confined area via solid walls, determining the location of a badge in such an office is impossible. Therefore researchers at AT&T labs came up with another technology using ultrasound called the Active Bat system.

### **Active Bat**

The basic idea behind the Active Bat project is to be able to locate a person/badge at any desire position in a place where Active Badges doesn't have much functionality. These devices use ultrasound technology to transmit signals to the receivers that are

installed at some intervals on the ceiling. Three receivers take the time of propagation of the ultrasound from the bat. Then by triangulation the position of the bat can be determined in three dimensions (figure below):



To allow accurate time of flight measurements, a wireless, cellular network synchronizes Bats with the ceiling receivers. Base stations simultaneously address a Bat over the wireless link and reset the receivers over a wired network. A wireless back channel supports the Bat's transmission of registration, telemetry and control-button information.

### **More Technical Side of Active Bat**

The dimensions of each bat are 8.0 x 4.1 x 1.8 cm, and each bat has a unique 48 bit ID, and uses a single AA lithium cell. Each device has two input buttons, and a buzzer

and two LEDs for output. A wireless network is used to send commands and generate feedback via these devices. And the central processor for all these bats is DSP microprocessor. The bats can also transmit telemetry data indicating their current battery level and firmware version number. Even more interesting is that these bats can be programmed wirelessly or through wired networks.

According to the documents provided by AT&T laboratories about 95 percent of 3D bat position readings are accurate to within 3 cm. Each base station can communicate with three bats simultaneously, 50 times each second.

To conserve the battery life of each bat, there are several algorithm implemented to put the bat in low power mode (sleep mode) whenever there is no need for the badge to communicate with the base.

## **Applications**

There are several applications for the Active badge/bat. Here are just a few of them that are currently being used/tested.

- Find a Colleague
- Immediately find a phone nearest to a person
- Determine to contact a person or not by their disposition

One of the most practical uses of active badges is to locate a person within the office building. This can come in very handy when workers in an office or a building tend to move around often.

Another application of Active Badge is to find a phone nearest to a person. This is useful when there is a need to contact a person via phone without having to page the whole building for that person.

In my opinion another interesting use for this device could be in prisons. If every prisoner is required to have a badge attached to him, a lot of security issues can be solved. The only slight addition to this system would be an alarm send to the base when the

badge has been opened or disabled. Since there are different gang members in the prison, if every person is identified to which gang he/she belongs, then by locating the gang members in the yard, we can avoid any potential problem. All that has to be done is to program the DSP to alert the officials in case if two rival gang members are getting to close to each other and so forth. Also any individual's location can be monitored at any desired time This device can save the prisons a lot of troubles. However human right activists will probably fight against the implementation of this device by saying that violates human rights.

## “Chip Implants”

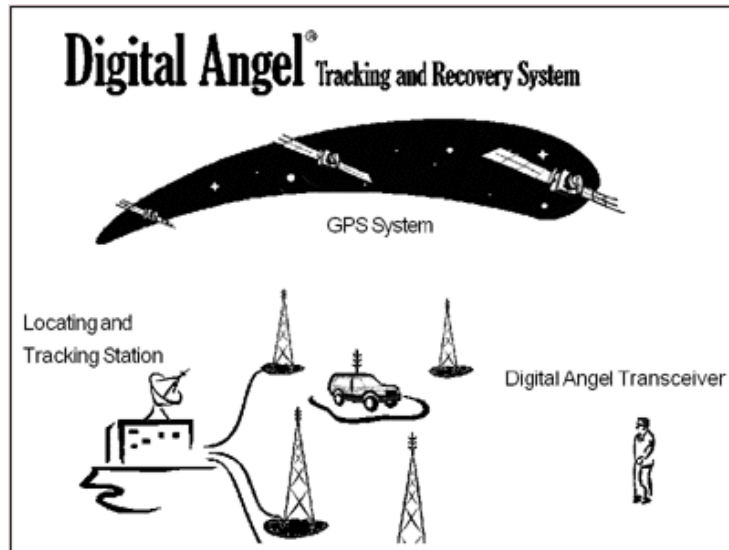
The Active Bat system is a very useful system for limited-range tracking. Provided that it is used with the user's consent, in locations such as a company office it can be invaluable in the absence of technologies such as cell phones. In comparison, implanted chip technologies from Applied Digital Solutions have a much broader scope in terms of customers, though it does come with its own drawbacks and issues.

### Digital Angel

Digital Angel is a medical/tracking system intended for consumer use by ADS. Originally conceived as a subdermally implanted (beneath the skin) device, it has combined tracking devices such as a Global Positioning System emitter and an advanced medical monitor that can track heartbeats, blood pressure and other vital signs.



The Digital Angel system is a transponder, though its function can be considered primarily as transmission. Its location and vital sign data are transmitted to a tracking station, after which data can subsequently be pipelined to those trying to monitor the Digital Angel user.



Plans for the product changed in June 2001 when it was announced that Digital Angel will be an externally worn device, taking the form of such things as a watch. The idea was not entirely gone, however; the Verichip, another device in the works by ADS, is an implanted device with simpler functional goals in mind.

### Verichip

Verichip is a technology that's gained a lot of attention recently. In essence, it is a small, rice-grain sized RFID chip that is embedded under the skin.

RFID, or radio frequency ID tags, is a scanner/emitter

system where the scanners emit low-frequency radio wave signals that can be caught by the tags. The tags, in reply, use their build-in radio emitter to return a small data value that is stored within the tag to the scanner. The radio waves being transmitted by the tag and the scanner works much in the same way as a conventional radio, operating at lower



frequencies around 130Khz (in comparison, AM radios operate at ~1000Khz, and FM radios at 100Mhz). Given the low power on the transmitters of these devices they are probably not suited for pinpointing locations of the devices that have the tags attached.

As can be seen from the picture above, the transmitter portion of the Verichip is primarily composed of a tightly wound coil. Its exact dimensions, according to ADS, is 12 mm by 2.1mm.

Because of the limited transmission range, RFIDs are more suited for barcode-like applications where the tags store a data value that identifies the item. Much in the same way, the use of the Verichip technology can be varied depending on how the stored data is used. By itself the identification number of a verichip would be quite pointless, but if that number is now linked to a medical database, it can quickly turn into a medical lifesaver if the user gets in an accident that renders him or her in an unconscious state.

### **Application**

Possible applications for these systems are quite numerous. The Digital Angel system is already being advertised as a well-functioning medical monitor. Along with biosensors that take readings of blood pressure, pulse and other vital signs, a user's position is always available. In terms of "monitoring" a patient the Digital Angel system can be of great use.

Verichip uses may not seem as diverse, but the fact that the technology is fairly inexpensive allows for a more widespread use of the technology. Since the chip itself would be merely an ID value, variations on the technology would be on the databases linked to the ID. Differing levels of access can be given to users, so that doctors may be able to pull out medical records from a user's database while landlords may be able to pull out past rental information. Just like homepages on the web today, 'public access' data could be optionally developed, so that handing out e-business cards and pulling out one's own resume can be done on the fly.

RFID technology is also advancing quite rapidly; some models, albeit at higher frequencies of ~400Mhz, have been used with built-in batteries that have a range of almost 80 feet and a lifetime of 4 years if the tag was to transmit a signal every two seconds. As RFID technology improves, so does the potential use of technology such as Verichip.

### **Issues**

Privacy issues seem to be the biggest hurdle with chip implants. Digital Angel is a prime example of this, as the technology took a shift from an internal to externally worn system in 2001. Though the real reason behind this is not clear, it can be attributed to the fact that concern for one's privacy may shy away possible customers. Of course, in the case of a fairly advanced monitoring system, a wearable version may also make it more appealing to hospital systems that can purchase a set and transfer them among patients as necessary.

Verichip has experienced similar difficulties. In October of 2002, request for FDA approval of the system was denied because Verichip did not want to comply with the request that medical records not be available within the Verichip's database. While relieving privacy concerns is important, in the case of technologies such as Verichip those restrictions can severely limit a product's potential. Progress may be on the way though: the Food and Drug Administration and the US department of Agriculture approved the use of Verichip technology in animals (non-human) in February of 2003.

If the effective range of Verichips increase, the product may become more useful but privacy concerns could potentially skyrocket. If a person was to own a RFID scanner he/she would be able to access public information about almost anyone that comes within range, a potential hazard when stalkers and the like are out on the loose.

The interesting thing about Verichip is that there is a huge divide between those who fear their privacy will be compromised with such technology, and those who are intrigued by its whiz-bang attributes. Young adolescents are perhaps the most enthusiastic, as those interviewed in *Wired Magazine* seemed to be primarily attracted to

the mystique surrounding new technology. Widespread use of the technology may be linked to whether these kids can adopt, and show to the adults, that the positives of this technology outweighs the negatives.

Active Badge's nature also results in some privacy concerns. Its limited range helps in this respect, as having the Badge on does not mean one can be tracked everywhere he or she goes. The fact that advanced mobile communication such as cell phones are much more widely available today can significantly reduce the use of Active Badge, but for uses where tracking the users are the primary objective (such as possible utilization of the technology in prisons) this is not much of an issue.

## **Conclusion**

Almost all useful technology has the potential to be misused. Active Badge and Verichip systems are no exception. Hopefully we have shown you what these technologies can do for us, and what we would need to be concerned about if we are to put these technologies into everyday use everywhere around us.

## BIBLIOGRAPHY

ACM Transactions on Information Systems, Vol. 10, No. 1, January 1992, pp 91-102.

Active Badges and Personal Interactive Computing Objects, Roy Want, Andy Hopper

A New Location Technique for the Active Office, Andy Ward, Alan Jones, Andy Hopper

*Applied Digital Solutions*. Nov 08, 2003. <<http://www.adsx.com>>

Brown, Doug. "YOU'VE GOT MEMS UNDER YOUR SKIN?  
SENSOR TO TRACK YOUR EVERY MOVE" *Small Times*  
<[http://www.smalltimes.com/document\\_display.cfm?document\\_id=3327](http://www.smalltimes.com/document_display.cfm?document_id=3327)>

"Chip Implants Already Here." *GreaterThings.com*.  
<[http://www.greaterthings.com/News/Chip\\_Implants/](http://www.greaterthings.com/News/Chip_Implants/)>

*Digital Angel*. Nov 08, 2003. <<http://www.digitalangel.net>>

"Digital Angel receives approval for chip, shares jump." *The Business Journal*.  
<<http://twincities.bizjournals.com/twincities/stories/2003/02/10/daily14.html>>

Implementing a Sentient computing System, Mike Adlesse, Rupert Curwen, Steve  
Hodges, Joe Newman, Pete Steggles, Andy Ward and Andy Hopper, August 2001

"They want Their ID Chips Now." *Wired*.  
<<http://www.wired.com/news/privacy/0,1848,50187,00.html>>