

# GPS Phone

## An Integrated GPS /Cellular Handset

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### BIOGRAPHY

Shon Shampain is Technical Lead for LocatorNet, a division of NAVSYS responsible for commercial GPS products and services. Mr. Shampain has twelve years software engineering experience, and has previously worked with organizations including The Goddard Space Flight Center (NASA), The Johns Hopkins University Applied Physics Lab (JHU/APL), Booz•Allen & Hamilton and ARINC.

### ABSTRACT

This paper will introduce the NAVSYS GPS Phone. Combining its rich experience in both GPS technology, and cellular communications, NAVSYS has been able to integrate the two technologies. The integrated GPS Phone device is a portable, handheld, fully-functional cell phone with GPS capabilities. The enabling technology in this device is NAVSYS' patented TIDGET GPS sensor.

### INTRODUCTION - WHAT IS GPS PHONE?

The NAVSYS GPS Phone is an integrated handheld device combining both GPS and cellular technologies. At approximately the size of today's current crop of cellular telephones, the GPS Phone is meant to be transported in a coat pocket, brief case, or pocketbook. NAVSYS, drawing on its broad and rich experience as a leader in the GPS field, has integrated cellular technology into a single device that effortlessly exceeds the year 2002 mandate for 125 meter location accuracy in cellular devices - today.

### What does the GPS Phone do?

At its essence, the GPS Phone is a fully functional cellular telephone. Additionally, its an emergency location device. By pressing one of GPS Phone's special keys, a user can indicate a request for police, fire, or roadside assistance. The choices do not end there because the GPS Phone can be customized for special applications (for example, the keys could be customized to report different traffic conditions -

congestion here, accident here, or smooth sailing). The GPS Phone is also capable of different modes of location services. Standard mode means that the GPS Phone is reporting a location. Finder mode means that a service center is attempting to location a GPS Phone unit. Tracker mode means that the GPS Phone will continuously report locations. The bottom line is that GPS Phone can serve many communications and location needs equally well.

### How can the GPS Phone benefit me?

There are numerous benefits to the NAVSYS GPS Phone.

- ◆ Every day, 911 is dialed approximately 60,000 times on cellular telephone devices, and of these calls, a full 25% cannot describe where they are<sup>1</sup>. The NAVSYS GPS Phone can drastically change these numbers.
- ◆ The year 2002 mandate for locating cellular devices will not help you for at least 5 years. The NAVSYS GPS Phone is functional right now.
- ◆ Many cellular phone makers are addressing the year 2002 mandate via techniques that depend on the cellular network, such as using the time difference of arrival (TDOA) of your cellular signal to nearby cell towers. Conversely, the NAVSYS GPS Phone uses the mature and stable GPS system. Additionally, the GPS system is accessible in virtually all areas of the world without the necessity of providing infrastructure additions such as special transponders and/or additional cell phone towers.
- ◆ In quantity there should be no significant difference between the price points of a cellular phone, and the NAVSYS GPS Phone.
- ◆ NAVSYS Corporation prides itself on "inventive GPS solutions". This means that GPS Phone is not cast in stone; NAVSYS can provide customization for specific applications.

- ◆ The NAVSYS GPS Phone is based upon significant experience in the field of GPS and cellular integration. In fact, there are various predecessors of GPS Phone based upon hand held technology, and in-vehicle technology.

## The NAVSYS GPS Phone

### System Architecture - TIDGET

GPS functionality in the NAVSYS GPS Phone is based upon the patented TIDGET™ technology. As opposed to a GPS receiver, the TIDGET™ is a GPS sensor. The difference between a sensor and a receiver is that a receiver will calculate a position at the device, whereas the sensor will send the raw GPS data to a base station for processing. There are various reasons why a sensor makes more sense than a receiver, and a number of situations when a sensor is superior to a receiver:

- ◆ Upgrades to processing occur once at the base station, instead of either issuing a field upgrade, or being stuck with obsolete technology
- ◆ The power for processing increasing drastically via workstation based computations, as opposed to a limited microcontroller or DSP that would be found on-board a device
- ◆ Differential corrections are standard fare in the base station, as opposed to a costly upgrade, or not having them at all
- ◆ All data is archived, implying that any run can be reproduced and verified
- ◆ The TIDGET/base-station concept enables the reporting of out-of-bound conditions, such as Dilution of Precision Warnings (DOPs), RAIM alarms, etc.
- ◆ The TIDGET/base-station concept allows tracking with as few as 2 satellites
- ◆ The NAVSYS GPS Phone has the ability to dispatch services, via its interaction with the LocatorNet Processing Center
- ◆ The NAVSYS GPS Phone has the ability to receive a location computed by the LocatorNet Processing Center, and display it
- ◆ The NAVSYS GPS Phone's lower power consumption allows the integration of GPS and cellular in a consumer device

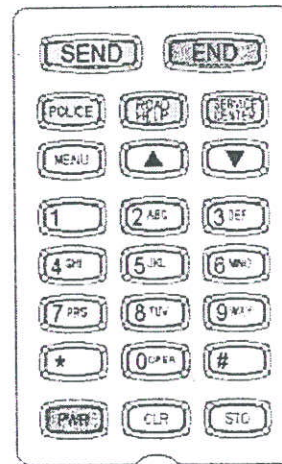
### Microprocessor

The microprocessor used for controlling the GPS Phone is based on the recently announced Phillips 8051 XA 16 bit microprocessor. This processor provides the GPS Phone with an extremely fast and powerful processing platform supporting up to two megabytes of program code and data storage, which will allow for system expansion far into the

future.

### Radio/Modem

NAVSYS has gone to great lengths to modularize the design with respect to the modem interface. Currently running a versatile serial connection, the current generation GPS Phone interfaces to the Sierra Wireless SB220 series of cellular communications devices. The NAVSYS GPS Phone also expects to achieve complete functionality with other integrated cellular phone/modem devices, such as INET, and other to be determined.



Keypad

### Keypad/Display/Speaker/Mic

The NAVSYS GPS Phone has the look and feel of a typical cellular telephone with an integrated user interface consisting of a multifunction keypad, four line LCD display and an integrated speaker and microphone.

### Cell antenna

The NAVSYS GPS Phone utilizes a typical quarter wave-type cell phone antenna.

### GPS antenna

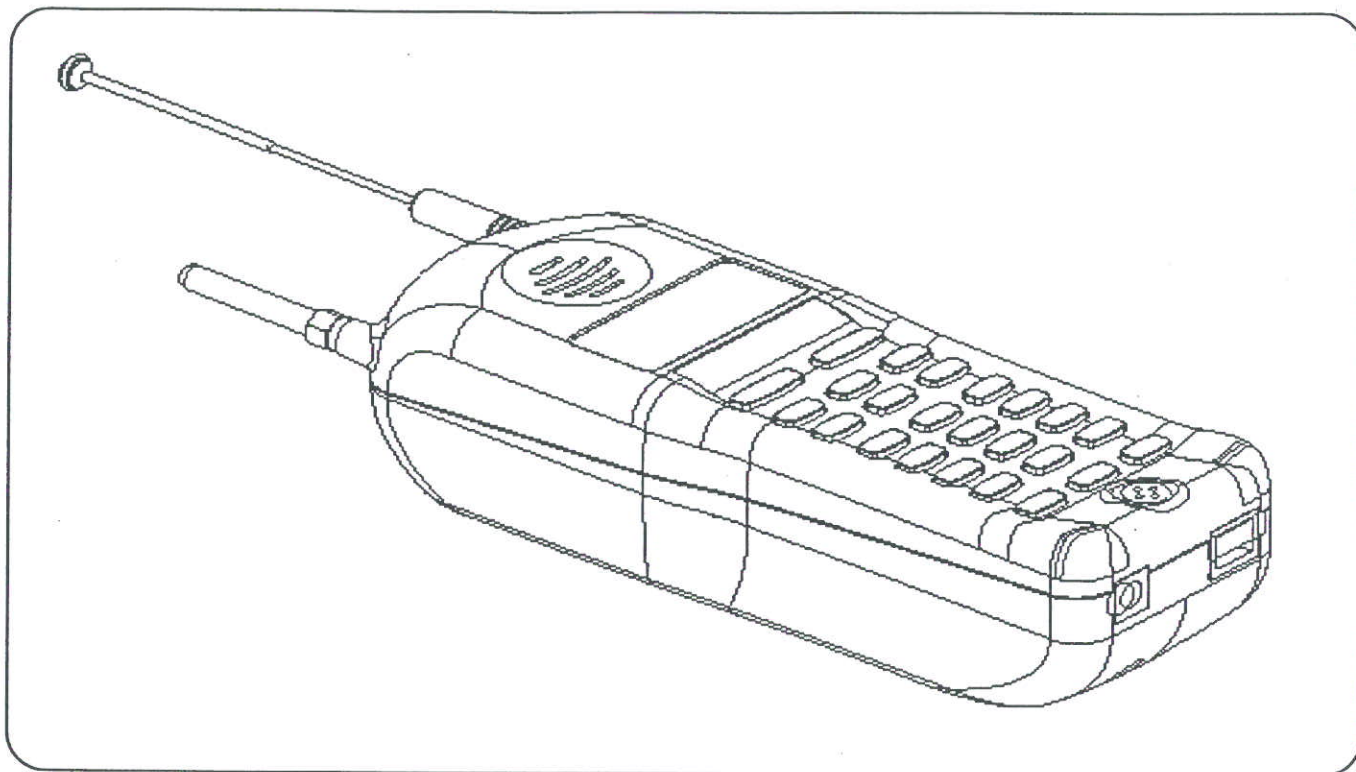
The NAVSYS GPS Phone is equipped with a new technology, helix-type GPS antenna that provides a passive or active device in a compact package.

### Functionality as a locating device in circuit-switched mode (AMPS) - Collecting GPS data

The GPS Phone is customizable with respect to the amount of data that is requested from the TIDGET sensor. The TIDGET sensor samples the L1 GPS spectrum at 2 Mbps, and provides a 1 bit analog to digital conversion. Therefore, each millisecond of GPS data takes 250 bytes. A setup specifying 20 ms of data will provide a differentially corrected accuracy of about 50 meters (1 sigma), while 100 ms of data will provide a differentially corrected accuracy of about 10 meters (1 sigma).

### Communications link

The standard communication link for the NAVSYS GPS Phone is a circuit-switched AMPS phone connection. This medium has many benefits, including the fact that it is widely supported in the US and the rest of the world. The effective data throughput works out to approximately 240



The GPS Phone

bytes per second (2400 baud). While planning for future applications, and with an eye toward modularity, NAVSYS' GPS Phone also supports CDPD as a data transport mechanism.

#### **Data transfer**

All data is transferred using standard 212-type modem data formats over a voice channel (AMPS) to the LocatorNet Processing Center. Relieving the GPS Phone of the responsibility of accurately time tagging the data, the LocatorNet Processing Center is capable of 1 millisecond time tags on the data it receives. All inbound data is placed into an Oracle database.

#### **Voice Mode**

Once the data transfer is complete, the call is transferred to another number. Residing at this other number might be a human dispatch operator. The function of this dispatch operator might be to gather additional information, or provide status back to the remote user. Another option might be simply a voice mail box. In this manner, non-critical applications have the opportunity to leave ancillary information.

#### **Utilizing CDPD**

Utilizing the advanced functions of many of today's cellular modems, the GPS Phone is capable of being configured in

CDPD mode. CDPD is a cellular protocol implementing TCP/IP over an AMPS cell network, and is designed for data transfer. In this way, the remote device can use standard TCP/IP communications protocols to transfer packet data.

#### **As a standard cell phone**

The location services of the GPS Phone do not have to be utilized, and there is no power penalty for having them on board when not used. The GPS Phone will function like any other cellular phone on the market today.

#### **Expandability / Flexibility**

Important in understanding the NAVSYS GPS Phone is understanding the NAVSYS mission of providing custom applications to customers who require them. By keeping important functionality in-house, and by utilizing the sensor/Processing Center approach, NAVSYS is able to tailor the GPS Phone to many different applications.

#### **Sending navigation solution back to unit**

The GPS Phone's 4 line by 25 character display is ideally suited to show the latitude, longitude and altitude computed by the LocatorNet Processing Center. Operations in this mode would involve either a call back, or a return packet with the relevant information. This mode would be particularly efficient in CDPD mode.

### **TRACKER mode**

The NAVSYS GPS Phone can be configured to continuously broadcast GPS information, enabling the Processing Center to track the unit. This option may be used with a time delay, say every 5 minutes, depending on application needs.

### **FINDER mode**

The Processing Center has the ability to initiate a call or request to the GPS Phone, and in this manner may poll the device to determine its location, without having had a button press at the unit.

### **Upgrades**

The NAVSYS GPS Phone's firmware is stored in flash memory, making uploading new firmware as easy as establishing the communications link.

### **Operations - User interface**

Operating the NAVSYS GPS Phone is centered around the user interface area, consisting of the display, keypad, speaker and microphone. The keypad, in addition to the standard numerical keys, has special keys, such as menu selection, cursor control and a set of special keys to designate requests for emergency services. The display is a high-contrast, back-lit display suitable for both day and night operation. The speaker and microphone are typical cell phone-issue parts.

### **Power Management**

The NAVSYS GPS Phone has been designed with an advanced power management system. In this system, a low power sleep mode is supported. The current draw during this mode is minimal, and is about the same as the standard discharge rates for off the shelf batteries. Additionally, to support instant on operations, the NAVSYS GPS Phone becomes operational after any of the critical buttons have been pressed (police, fire, etc.).

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### **Packaging & modular design**

In an attempt to emphasize the flexibility of this unit, NAVSYS has designed a number of different unit housings. For military use, the enclosure is a ruggedized green case. For emergency personnel, the enclosure is bright orange. For commercial applications, the enclosure is similar to a standard cell phone.

### **Applications - Currently targeted markets**

The currently targeted market for the NAVSYS GPS Phone is the consumer market. Depending on the services that a potential customer would like to target, the GPS Phone can be configured as a safety device (for example, police, fire

and 911), or a convenience device (roadside assistance, directions, 911). The form factor suggests that it is appropriate for "shirt pocket" applications, such as those desired by current cell phone users. It is important to remember that NAVSYS Corporation, whose motto is "Inventive GPS Solutions" is willing and capable of modifying this unit to suit other markets.

### **Versatility - potential markets**

The possible markets available to the NAVSYS GPS Phone are vast. When the location is sent back to the GPS Phone, the GPS Phone will, for all practical purposes, function as a typical GPS receiver. Due to its small footprint, low power, and impressive accuracy, the GPS Phone is an ideal candidate to replace large, power-hungry in-vehicle units. Due to its substantial configurability, the NAVSYS GPS Phone is a strong candidate in the government/municipality arena, where resource tracking is critical. Surveying is another incredibly rich potential market for the NAVSYS GPS Phone; configured with a PCMCIA memory card, or equivalent, surveyed points not only can be calculated, but the data used for the calculation can be saved as well - this would eliminate the entire error process associated with transcribing coordinates.

### **The Future of the GPS Phone**

#### **TIDGET in a 1 or 2 chip Phillips solution**

The NAVSYS mini-TIDGET, which is the current TIDGET iteration used in the GPS Phone, will soon shrink to a 1 or 2 chip solution.

#### **Modem - PCMCIA-like stripped radio/modem**

Many radio/modem manufacturers are approaching the PCMCIA form factor for their radios and modems. Some, like INET, have successfully integrated the radio and modem on one card. The integrations to these platforms are currently underway.

#### **Combination antennas**

Many antenna manufacturers are working on combination GPS/cellular antennas. Prototypes for these units are currently in house.

#### **Other protocols**

Circuit-switched AMPS and CDPD are simply the communications protocols being used today. Tomorrow, one might expect GSM or other platforms.

#### **Base band integration**

Eventually, due to its impressive list of partners, NAVSYS will integrate all components of the GPS Phone with all components of the radio/modem, for a single board solution. The savings in cost and form-factor will continue to make this product appealing.

## **CONCLUSION**

Via its patented TIDGET technology, NAVSYS has enabled the integration of cellular and GPS into a single device. The GPS Phone as a commercial device encompasses NAVSYS' significant research and development in the GPS arena. Given that its quantity price point is the same as today's cellular phones, the NAVSYS GPS Phone should clearly emerge as the communications device of choice.

## **Acknowledgments**

The author would like to recognize the Hardware Team for GPS Phone. Led by NAVSYS Senior Engineer Chris Orth, this team is responsible for hardware design, prototyping and eventual production devices. Additional contributions to the Hardware Team were made by Senior Systems Engineer Jim Goosman, and Engineer Bryan Conner. The author further recognizes Max Cameron, President of the NAVSYS division LocatorNet, for contributions and the overall vision of this effort.

The author would also like to recognize Technical Lead Ian Longstaff, who got the GPS Phone effort off the ground, but due to his many and varied skills was pulled onto another project. Last but not least, Mr. Ron Dennis from DARPA is to be recognized for his contributions and funding for this effort.

## **References**

1. The Denver Post, August 25, 1997