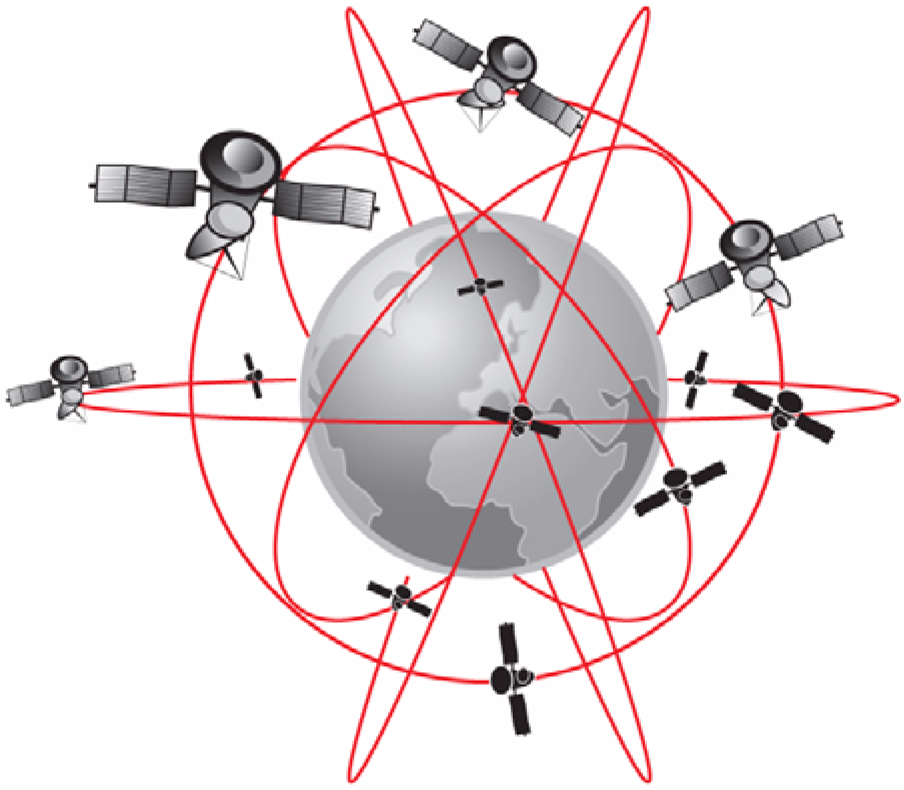
White paper

June 2007

GPS and A-GPS



Sony Ericsson

Preface

Purpose of this document

This White paper offers the reader a quick overview of the GPS (Global Positioning System) and A-GPS (Assisted GPS) technology.

People who can benefit from this document include:

- Operators
- Service providers
- Software developers
- Support engineers
- Application developers

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Sony Ericsson Developer World

On www.sonyericsson.com/developer, developers will find documentation and tools such as phone White papers, Developers guidelines for different technologies, SDKs and relevant APIs. The Web site also contains discussion forums monitored by the Sony Ericsson Developer Support team, an extensive Knowledge Base, Tips & Tricks, example code and news.

Sony Ericsson also offers technical support services to professional developers. For more information about these professional services, visit the Sony Ericsson Developer World Web site.

Document history

Change history		
2007-06-07	Version 1	First revision

Contents

Technology overview

Traditional positioning technology based on the Global Positioning System (GPS) has mainly been used for navigation. Today, however, there is an increased demand for services that are relevant to the users at their specific location. With the mobility offered by mobile phones and the wireless network, a variety of location based services (LBS), such as asset tracking and emergency services, can be made available when needed.

Although the GPS receiver is very suitable for providing accurate location, it needs some assistance in order to be suitable for the new LBS in mobile phones. For example, it can take several minutes for a GPS receiver to collect all the data needed to compute its location. Positioning in the mobile phone network, on the other hand, is very fast but lacks the precision provided by the GPS.

The development of mobile phones with embedded GPS receivers has been fuelled by the E911 mandate, the recent development of high-sensitivity GPS chipsets, and the increased use of turn-by-turn navigation.

With the E911 mandate the American operators have been required to make the location of a mobile phone available in the event of an emergency. Similar regulations are now being discussed within the European Union, but no decisions have been made.

Based on location accuracy and low infrastructure cost, Assisted GPS (A-GPS) is the technology that has been chosen as the front runner for mobile phone applications.

Advantages

Consumers

- Can use turn-by-turn navigation when driving, without any additional equipment. Moreover, the mapping material is always up-to-date.
- Can use services that are augmented with information about the current location.
- Can use emergency services.
- Those users that today use Bluetooth solutions will not need to charge and carry two separate units.
- The acquisition times will be faster with A-GPS.

Operators

- The data traffic will be increased thanks to the mapping services.
- Can gain customers who want emergency services using C-plane A-GPS and E911.
- Can gain business customers who want to use asset/people tracking.
- Will be a part of the growing navigation market.

Service providers

- Opportunity for new services
- Chances of gaining the same effect that WAP2.0/XHTML had on the mobile Web

Future

Future GPS chips will increase performance while size and cost are decreased. Future availability of other satellite navigation systems such as Galileo, Compass and GLONASS, as well as improved GPS signal characteristics, are also expected to increase the performance of the navigation systems.

Functionality

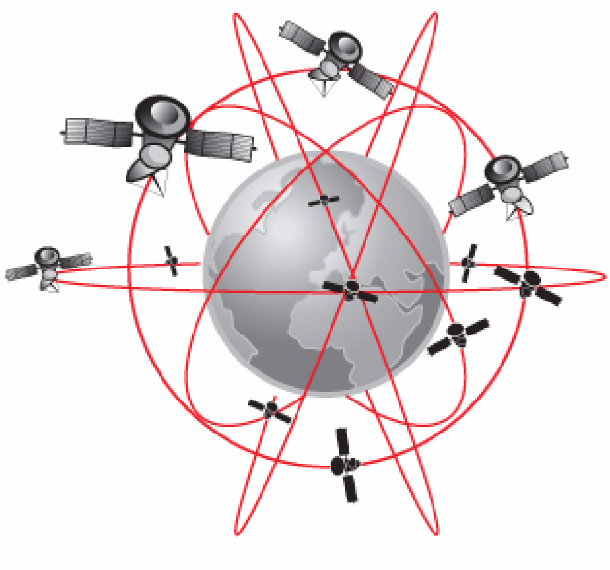
- Turn-by-turn navigation
- Friend-finding applications
- Safety services — with alarms when leaving or entering certain zones
- Location information attached to contacts
- Location information sent using SMS, MMS and email.

GPS basics

Like a mobile phone, a Global Positioning System (GPS) receiver relies on radio waves. However, instead of using towers on the ground, it receives signals from satellites orbiting the earth.

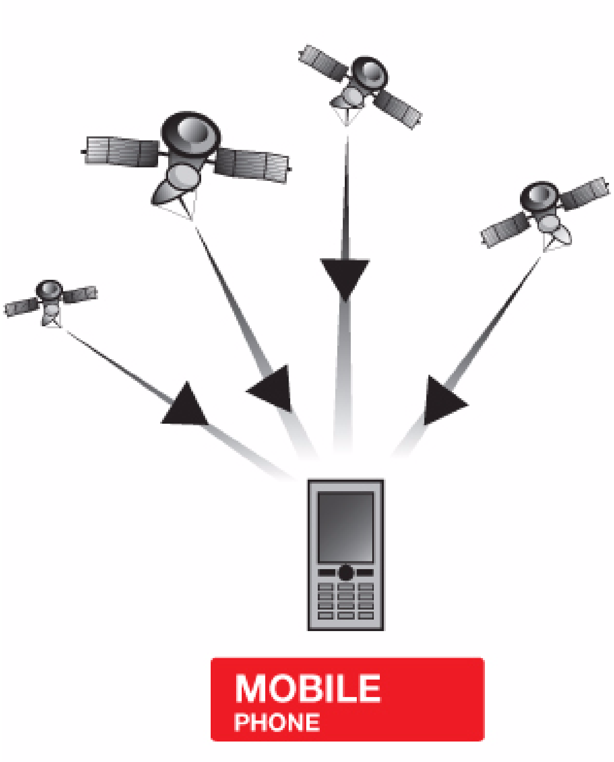
The GPS network was developed and implemented by the U.S. Department of Defense as a military navigation system, but soon became available for civilian use as well. It consists of at least 24 earth-orbiting satellites.

All satellites circle the globe at about 12,000 miles (19,300 km), making two complete rotations every day. The satellites are placed in predetermined orbital planes designed to give full geographic coverage.



The GPS system works on the principle that if you know your distance from several known locations, you can calculate your own location. The known locations are the GPS satellites, and the distance is achieved by measuring the time it takes for signals from the satellites to reach the receiver. All GPS satellites synchronize operations so that the signals, containing satellite positioning data, are transmitted at effectively the same instant. The signals move at the speed of light and arrive at a GPS receiver at slightly different times, because of the varying distance from the satellites. The receiver can then calculate its position by measuring the time of arrival of the signals. This is done using a mathematical principle called trilateration.

Theoretically the GPS receiver needs to have a direct view of three satellites to locate a position on earth. However, in practice, four satellites are needed to improve accuracy and provide a three-dimensional location. The reason for this is mainly that to calculate its position, a receiver needs to know the precise time. While the satellites contain atomic clocks that can be accurately synchronized, with any drift between satellites being measured and taken into account, the less expensive clock within the receiver is not able to maintain accurate synchronization. Therefore one additional satellite is used for a precise position to be calculated even when the receiver clock is in error.



GPS receiver start-up time

When turned on, the GPS receiver searches for satellite signals. When a signal is found, the data stream that is broadcasted from the satellite is decoded. The data stream includes the precise orbital parameters for that satellite. This information is needed to be able to use the satellite for navigation and is valid for about 2 hours. Due to the slow data rate, it takes about 30 seconds to download and decode this data stream if the signal environment is good. In bad environments this can take several minutes, if it is possible at all.

A moving receiver often needs longer time to download and decode the data stream than a receiver that does not move. The reason for this is that if the satellite signal is lost, which is likely to happen when a user is travelling by car in urban environments, the receiver has to restart the decoding sequence. However, the most recent orbital data is kept when the GPS receiver is turned off. This means that if the receiver is started again before the orbital data has become invalid, the start-up time is almost instantaneous as long as satellite signals are still available. This is called a warm start. If the receiver, on the other hand, is started when the orbital data has become invalid, the start-up time is much longer. This is called a cold start.

GPS in mobile phones

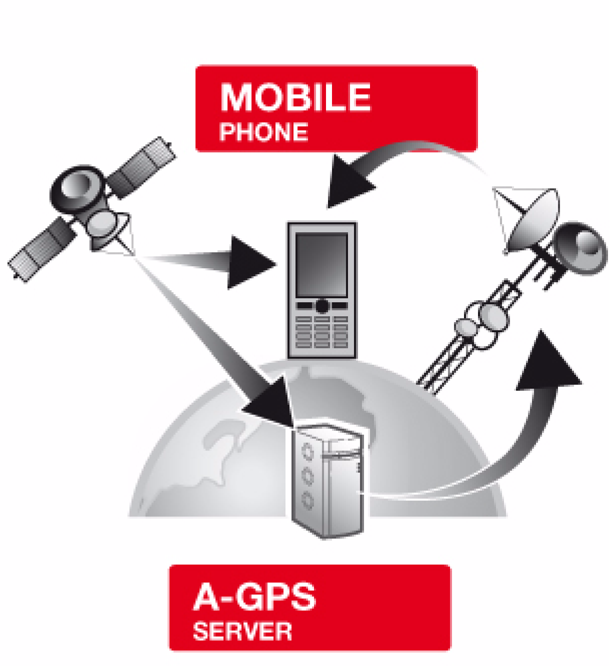
Although GPS has been available in standalone equipment for some time, the transition to incorporate the GPS receiver into GSM/UMTS devices has taken some time. Reasons for this are cost, size, performance and lack of services.

One of the most obvious problems with GPS for mobile phone applications is that signal levels are low and that, for example, dense tree cover and buildings can prevent a direct view of the satellite. The time it takes for the receiver to establish contact with the satellite and calculate its position can be several minutes from the time that it is turned on. This is unacceptable for the typical mobile phone consumer, who is used to applications that work in a few seconds.

A-GPS

The idea behind Assisted GPS (A-GPS) is to decrease the start-up times so that it does not take longer than a warm start, even if the receiver has not been on during the last couple of hours. To achieve this, resources other than the GPS satellites help the GPS receiver to gain the information needed to find the satellite signals and to calculate its position.

In addition to GPS satellites and GPS receivers, the receiver in an A-GPS network communicates with an assistance server. Since the A-GPS receiver and the assistance server share tasks, and the assistance server has high processing power and access to a reference network, the process is quicker and more efficient than regular GPS. For example, the assistance server can take care of precise GPS satellite orbit and clock information. This information is computed by the assistance server, to make initial position and time estimates, and then communicated to the receiver through the mobile network.



The result is not only significantly reduced time from when the GPS receiver is turned on until a position is calculated, but also greatly improved customer satisfaction when using LBS.

E911 and E112

The E911 mandate is issued by the American Federal Communications Commission and requires American operators to be able to locate mobile phones in case of emergencies. To be able to meet these requirements, the possibility to aid the GPS receiver using assistance data is very important. The European E112 service, on the other hand, does not so far specify the accuracy and reliability of the positioning system to be used. Therefore it is not likely that emergency positioning alone will be enough for European operators to invest in A-GPS infrastructure. As a result, there are two standards for A-GPS available with different main objectives — one that is fast and reliable and one that is cheap and easy to implement.

Both standards, however, ensure interoperability between service providers, phone manufacturers and operator networks that implement the same standard.

Navigation basics

The availability of a fast communication channel opens up for the possibility to download map information from the Internet rather than storing this information in the device.

On-board navigation

With on-board navigation, the maps are stored locally on the navigation device and the route calculation is also done on that device. This means that the device does not need contact with any network to perform the calculations. However, the maps can only be updated by buying new and updated maps from the map supplier.

Off-board navigation

With offboard navigation, the maps are held on a central server. The navigation device sends the current position and desired destination to the server that calculates the route. The route and the required maps, including additional information in case of wrong turns, are then sent back to the device. This means that the map information is always up-to-date, dynamic information such as traffic information can be included, and there is no demand on large storage capacity. However, the navigation device must be connected to the server through a high speed data connection such as GPRS or 3G.

Applications

Google Maps™ for mobile and Wayfinder Navigator™ are available in the Sony Ericsson mobile phones (depending on the market and the availability of the service in the specific market).

Google Maps™ for mobile

Google Maps™ is a Java™-based application that can be very handy when the user is out and about.

GPS

When the current position is acquired by the GPS receiver, the user's current position can be shown. The user can also enter an address, intersection or general area to quickly find it on the map.

Pan and zoom

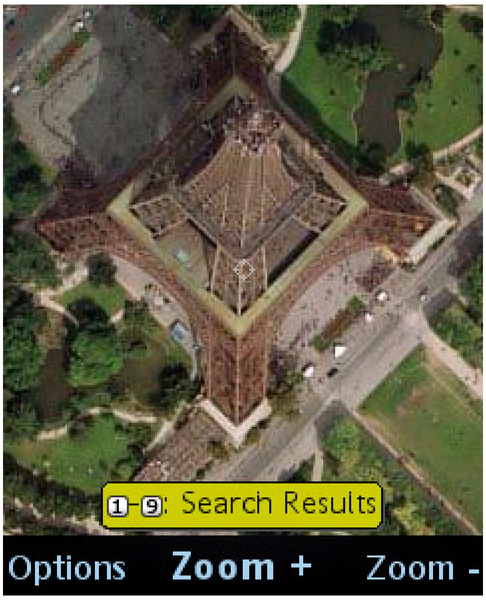
Google Maps™ features a map that can be navigated by paning around to move to the desired location or zooming in or out to show detailed street information. As the user navigates, additional information is downloaded from the server and displayed.

Searching

Search results can be restricted to a certain area. For example, someone can enter a query such as "Waffles in Ottawa" to find restaurants serving waffles near the city. This can be used to find a wide variety of businesses, such as theatres, restaurants and hotels.

Satellite view

The user can switch between map view and satellite view to see what a location looks like before getting there.



Route calculations

When calculating routes, a step-by-step list of how to get to the destination is provided, along with an estimate of the time required to reach it and the distance between the two locations.

Favourites

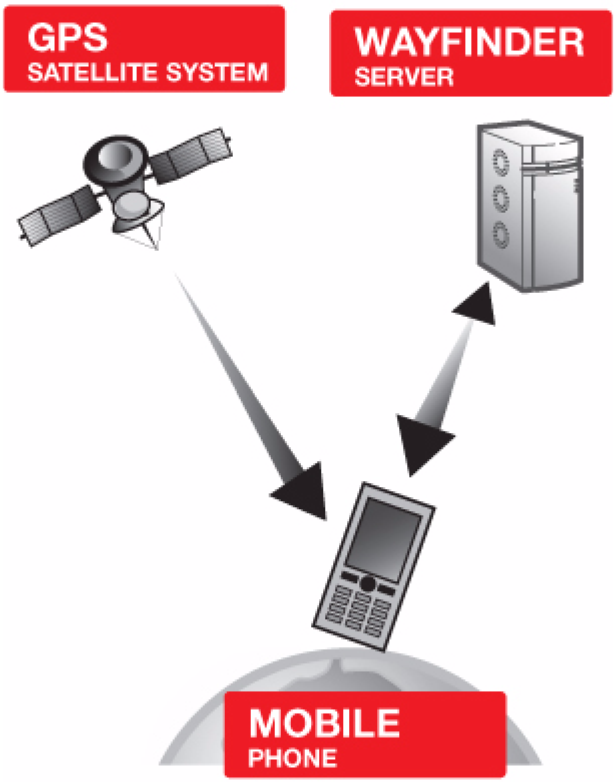
The user can save favourite locations to find them again in the future.

Wayfinder Navigator™

Wayfinder Navigator is a Java-based application that provides the user with turn-by-turn directions.

GPS

Wayfinder Navigator is an off-board navigation system. The current position is acquired by the GPS receiver in the mobile phone. This information, together with the destination that the user searches for, is sent to Wayfinder's up-to-date navigation server. When the optimal route is calculated all routing data is downloaded to the phone. If the map navigation view is used, maps are downloaded while driving.

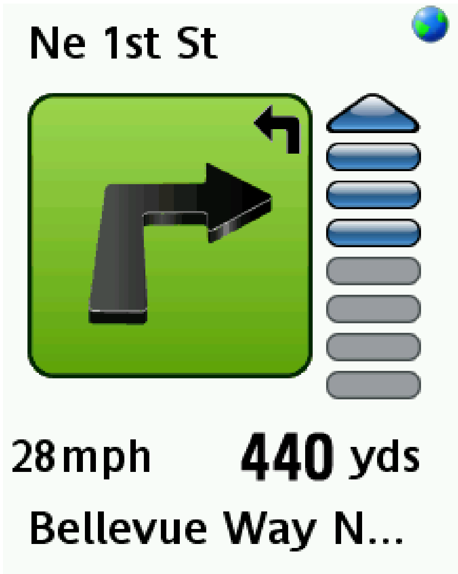


Free trial version

Three months usage of Wayfinder Navigator is included. When a user is registered, the mobile phone number and IMEI number is automatically transferred and a Wayfinder user account is created. After the trial period the user can select from different subscription alternatives.

Turn-by-turn directions

Turn-by-turn directions are shown on the display and announced through the phone speaker. GPS information such as speed is also shown, and the route is automatically re-calculated if the user takes a wrong turn.



Searching

With Power Search, the search functionality within Wayfinder Navigator, the user can simultaneously search in multiple databases and have the search result listed for each database. Wayfinder includes information from many data providers such as Tele Atlas, Wcities and local yellow pages and white pages suppliers.

Options

The user can, for example, change between 2D and 3D maps, change to night mode, save favourite locations to find them again in the future, and change the measurement system.

Traffic information

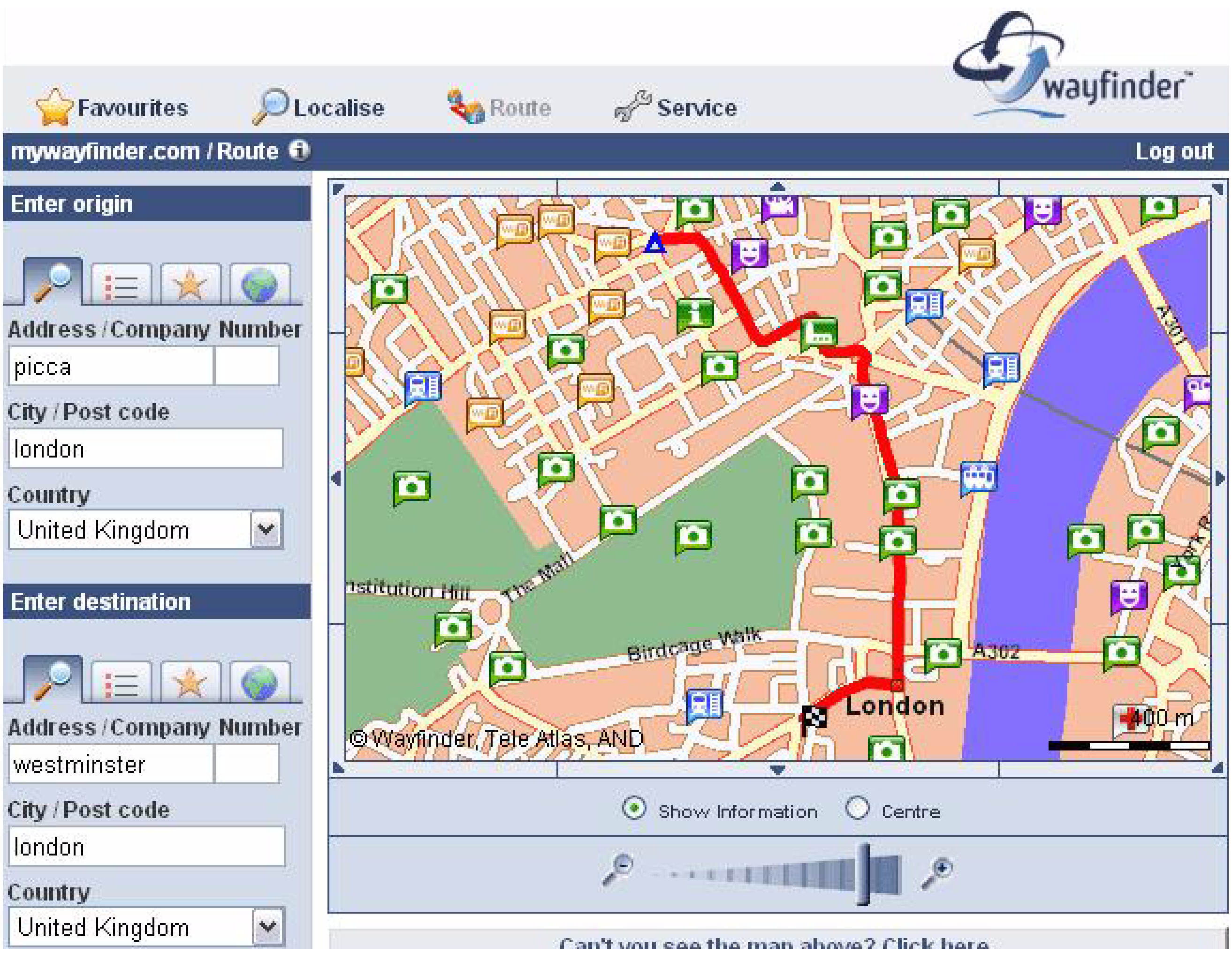
For the European markets where traffic information is available*, details about accidents, road constructions and other reasons for traffic jams are included to help the user select the quickest route to the destination. The traffic information is taken into consideration when calculating the route and it is also visible as icons with text information in the map display.

The user can also enhance the navigation experience by leveraging on speed camera locations where the known risk of accidents is highest. To have advance warning of speed cameras, both by audio and visible in the map, makes the user aware of upcoming danger spots considerably earlier than that moment of sudden, last-second panic-braking.

*Traffic information is currently (Q2 2007) available in Sweden, UK, Germany, The Netherlands, Belgium, Italy, Spain, Austria, Switzerland and Finland

MyWayfinder.com

MyWayfinder.com is a comprehensive Web-based planning tool that is fully integrated with the Wayfinder application in the phone.



With MyWayfinder.com the user can:

- Plan trips in advance
  Routes can be generated and the user is provided with detailed maps and instructions on how to get to the destination.
  The routes and maps can be sent via email free-of-charge to friends.
- Search for addresses, companies and Points of interests (POIs)
  The search result can be viewed on a map and used as route origin and destination.
  It is possible to find out more about the POIs by clicking on them on the map. For many POIs a detailed review will be presented.
- Panorate and zoom in and out of the map
- Store favourites
  The Favourites are automatically synchronized with Wayfinder Navigator in the phone when the application connects to the server the first time.
  The Favourites can also be synchronized manually by the user through a menu option.
- Get on-line support or get in touch with the live support
  Internet access points can be configured using MyWayfinder.com.
  Support is available in the form of an on-line user handout and FAQ.
- Extend the subscription after the trial period and buy additional services via the integrated Mobile shop

The username for MyWayfinder.com is found under Settings in the phone application, and that is also where the password is set.

Technical aspects

This chapter offers a detailed description of the technical aspects.

Architecture

The basic components in the GPS architecture are:

- Assistance data server
- Local GPS receiver or access to assistance data network
- Cell database

Standards

Apart from stand-alone GPS Sony Ericsson support both control plane A-GPS specified by 3GPP™ and Secure User Plane for Location (SUPL) A-GPS specified by OMA. The main difference between these standards is that control plane uses GSM/WCDMA control channels, while SUPL uses standard TCP/IP channels for communication. Due to these differences the standards also differ in implementation and functionality.

Control plane A-GPS (3GPP™)

By incorporating A-GPS functionality in the core network and control channels, the control plane A-GPS implementation is as robust and reliable as the rest of the network. These characteristics make control plane the obvious choice for emergency positioning such as the E911 service.

Due to the tight integration in the network, this A-GPS implementation is very dependent on the current network structure. Operators with multiple radio access networks (GSM/UMTS) will need to implement A-GPS in both networks for full coverage.

Although the A-GPS implementation in the network is very robust, the GPS receiver still needs to be able to receive the GPS satellite signals to be able to calculate its position.

When the user is located in a roaming network, the possibility to use A-GPS services is decided by the existence of a control plane A-GPS implementation in the visited network.

SUPL A-GPS (OMA)

Since the SUPL A-GPS implementation uses standard TCP/IP communication in the already existing GPRS network, it is very easy to implement in the network. The same hardware can even serve several radio networks of different types. This is very useful for operators with both GSM and UMTS networks. However, the user needs correctly configured GPRS settings and a user on a prepaid contract needs to have enough credits available to download assistance data. In most GSM networks simultaneous voice and data channels are not supported. On the one hand, these characteristics make SUPL A-GPS implementation less suitable for emergency services than the control plane implementation. On the other hand, the fact that SPUL is cheap and simple to implement will probably make it a very interesting alternative for operators not affected by the E911 service reliability demands.

The SUPL Location Platform (SLP), which handles all the SUPL communication, can be placed anywhere in the Internet, but will still need integration with the core network for billing and authentication.

Since the SLP can be reached from the Internet, even a user in a roaming network will be able to receive assistance data from the home SLP. To be able to get the advantage of having a reference location, an SLP that can inform the GPS receiver about its current reference position is needed in the roaming network.

JSR-179

The JSR-179 is a standardized way of accessing location services through Java applications and is a part of Mobile Services Architecture umbrella standard (JSR-248). By supporting this we ensure that Java applications developed according to this standard will work on Sony Ericsson phones. The JSR-179 does not rely on any particular GPS/A-GPS implementation. As a result of this all JSR-179 applications will work with both control plane and SUPL A-GPS implementations as well as with a stand-alone GPS receiver.

Example

```
LocationProvider l =
LocationProvider.getInstance(new Criteria());

Location loc = l.getLocation(60000);

QualifiedCoordinates coord =
loc.getQualifiedCoordinates();

double lat = coord.getLatitude();

double lon = coord.getLongitude();
```

FAQ

This chapter offers some frequently asked questions.

How to decide if assistance data should be used?

This is decided by the availability of A-GPS support by the network and can be customized to suit operator preferences.

Does A-GPS work when roaming?

SUPL A-GPS will be able to download assistance data wherever there is a GPRS roaming agreement. To get a correct reference location the visiting network needs a SUPL implementation and a SUPL roaming agreement.

For control plane A-GPS to work, the visiting network needs a control plane A-GPS implementation and a roaming agreement.

Will A-GPS have better indoor performance than a regular GPS receiver?

The GPS receiver will probably not be able to calculate its position indoors. The probability of A-GPS to work indoors is, however, higher because of the use of assistance data. When using assistance data the receiver will be able to find and track signals from more satellites than a regular GPS receiver. This will give the A-GPS receiver better indoor performance than a stand-alone receiver, but since the receiver still relies on satellite signals it will still not be able to calculate its position in conditions where the signals are too weak.

What is done to support privacy?

The user can choose whether to allow incoming location requests or not.

The privacy function can be overridden by emergency services.

Abbreviations

3GPP™

3rd Generation Partnership Project

A-GPS

Assisted GPS

GPRS

General Packet Radio Services

GPS

Global Positioning System

GSM

Global System for Mobile Communications. GSM is the world's most widely used digital mobile phone system, now operating in over 100 countries around the world, particularly in Europe and Asia-Pacific.

The GSM system family includes GSM 850, GSM 900, GSM 1800 and GSM 1900. There are different phases of roll-out for the GSM system and GSM phones are either phase 1 or phase 2 compliant.

LBS

Location Based Services

OMA

Open Mobile Alliance

POI

Points of interest

SLP

SUPL Location Platform

SUPL

Secure User Plane for Location

Related information

Links

http://www.jcp.org/en/jsr/detail?id=179

http://www.openmobilealliance.org/release_program/supl_v1_0.html

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