A USER FRIENDLY LOCATION REFERENCING SYSTEM

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BIOGRAPHY

Peter H. Dana. Mr. Dana is an independent consultant in electronic navigation, precise positioning and geographic information systems. He specializes in software for signal processing, navigation filtering, and position display for Loran-C and GPS receivers and systems. He is currently a Ph.D. candidate in the Department of Geography of the University of Texas at Austin. He is a member of the American Association of Geographers, the American Congress on Surveying and Mapping, the International Loran Association, and the Institute of Navigation. He is the author of a popular Web Site on Geographic Referencing Systems located at: http://www.utexas.edu/depts/grg/gcraft/notes/coordsys/coordsys.html.

S. Lee Hancock. Mr. Hancock is the President and founder of Go2 Software, Inc., which designs, develops, and markets a user-friendly location referencing system designed for use with GPS and other electronic navigation devices.

ABSTRACT:

The authors have designed and developed a user friendly geographic location referencing system (the "System"). It is a hierarchical system specifically designed for use by the general public in connection with GPS and other electronic navigation devices. The System is capable of universal coverage, and produces at least one unique address for any location in the United States. The System is based upon a combination of referencing methods using existing political and geographic features, and the user interface includes features designed to reduce the input required to identify particular locations. In addition to the ability of the location referencing system to provide a universal reference for any location, the System includes unique methodologies to designate mnemonically associated identifiers for specific locations. These identifiers are coordinated with the universal location referencing aspects of the System in order to enhance the utility of the System for use by the general public. The System also includes methodologies designed to coordinate the use of the System with paper and electronic maps.

Objectives of the System

The System has been designed for various types of commercial applications which can benefit from a user friendly consumer interface. For example, the intelligent transportation system industry has a need for standard location referencing which provides an interface that can be easily understood and used by the general public. Another example of the use of the System is in the emergency services sector. In the absence of electronic transmission of location information, it is important for police, fire, and medical providers to be able to obtain accurate location information, and the System is specifically designed to allow non-technical users of GPS and other electronic navigation devices to quickly and efficiently communicate their location information with less confusion and ambiguity than traditional location referencing systems.

The System is designed to compliment and supplement GPS and other electronic hardware and software navigation systems of all types, including navigation databases and digitized maps that are currently being designed and marketed for use by the general public. The System design includes database capabilities which

will provide discreet, alpha numeric identifiers for specific locations, and its primary design objective is simplicity and ease of use by the general public.

The System is not intended to replace existing methods and/or sophisticated mapping software and databases, but rather to provide a much needed component of those systems -- a universal address that can be used by the general public.

Current Consumer Interfaces

The basic input/output or universal coordinate systems for electronic navigation units designed for consumer uses generally rely on standard latitude and longitude coordinates. More sophisticated and expensive electronic navigation systems, primarily designed for automotive navigation, can provide digitized street maps and electronic databases. The input/output methods for these systems generally rely upon standard street addresses (which by necessity must include the appropriate city and state) or a menu driven selection process which accesses a database of locations or destinations based on attributes of the location.

Other Coordinates Systems

There are numerous other coordinate systems which have been developed and used for location referencing. Some of these have very specific audiences, and some relate only to certain geographic areas. These systems include Universal Transverse Mercator (UTM), Military Grid Reference System (MGRS), World Geographic Reference System (GEOREF), Maidenhead, U.S. Topographic Map references, TNL (Trimble) Grid, Trimble Atlas, and Thomas Brothers Detail. In addition, State Plane coordinates (SPC), Public Land Rectangular Surveys, and Metes and Bounds are often used to identify certain locations or property boundaries, and certain other location referencing systems, such as zip and other postal codes and telephone area codes, could conceivably be utilized as a basis for a standard, user friendly location referencing system for the general public. Set forth below are the actual location identifiers for a particular location in Santa Ana, California under some of these systems. This list is not intended to include all location referencing system, but rather those which are more predominant and/or are available for use primarily by the general public in electronic navigation devices and programs.

Latitude/Longitude	N 33' 37.054 E 117'52.409
Maidenhead	DM 13 BP
US Topographic Map (Trimble Over & Up Method)	Newport Beach, CA 1B Over 2.58" Up 0.58"
UTM Kilometers	11 417.3 S 3721.1
TNL(Trimble) Grid Locator	DM 13 BP 20 YT
Trimble Atlas	R6 Los Angeles-S ap 408 E1 rp 14 B5
Typical Street Addresses:	18301 S. Pacific Coast Highway, Newport Beach, CA

Some of the foregoing identifiers do not provide enough accuracy to precisely identify the location, particularly the Maidenhead and U.S. Topography Map using Trimble's Over & Up method. Others have tremendous storage or database requirements to work properly.

The System described in this Abstract represents an effort to combine several features of universal coordinate systems in a fully integrated location referencing system, including universal coverage, short and unambiguous referencing, capability of extreme accuracy, minimal storage and database requirements, and a consumer oriented, user-friendly interface.

System Attributes-In General

The System addresses consist of alpha-numeric addresses for specific geographic locations. The System includes two distinct types of addresses:--Universal addresses and Proprietary addresses, and in addition, the System utilizes various other methods, including simple artificial intelligence methods and Map Codes, designed to make the System very user friendly and minimize the keystrokes necessary to identify particular locations.

The System provides a method of establishing a local horizontal coordinate grid with a minimal set of descriptors tied to global geodetic reference frames. Although it is based on many of the principles found in other coordinate systems for horizontal position description, it is designed primarily for use by non-technical users unskilled in geographic referencing. As with latitude and longitude, the System's descriptor can be presented with increasing precision by using more significant descriptors. As with the Military Grid Reference System (MGRS), the designators can be abbreviated by leaving off the most significant

descriptors when the geographic context is known. As with simple arbitrary grid reference grids of the "J-7" type often found on city maps, the System can be used to simply refer to a grid square on any map.

Universal Addresses

The System's design allows a universal location reference for any location throughout the world, although the System's design has initially been limited to locations in the United States because of datum, language and other technical issues. The System's algorithms allow all electronic hardware and software products to translate traditional latitude/longitude coordinates into the Universal address for any specific location. Universal addresses in the United States are based on States and Cities in order to make universal addresses more user-friendly for the general public.

The heart of the System is its use of a list of city centroids grouped by state/province and county codes. These are used to establish a grid coordinate system based on specific values of latitude and longitude within a global geodetic framework. The System is based on the World Geodetic System 1984 (WGS-84). By replacing the most significant values of latitude and longitude with state and city codes, the System provides alphanumeric designators that can be easily communicated and that can be used to express location with a minimal number of characters. While the System is primarily designed for use within the United States, Canada, and Mexico at this time, for a location that must be specified globally, country codes, state/province codes, and city codes in alphabetic format can express locations any where in the world unambiguously and with any required degree of precision. Because the System is based on a known global geodetic datum, conversion to other local systems is also easy to accomplish.

The System's city grid identifiers consist in full form of a country code, a state/province code, a city code, and a set of easting and northing values expressed in a series of designator pairs with increasing precision as pairs of easting and northing characters are added to the right. A complete location reference under the System might be "US.CA.NWB.45.67.47.52." This address would represent a geodetic latitude and longitude of 33 degrees, 37 minutes, 43.2 seconds of north latitude, and 117 degrees, 53 minutes, 33.0 seconds of west longitude, to precision of about 20 meters. By referring to "CA.NWB" one can designate an area around a city such as Newport Beach, California to any level of precision. In this example, the city grid provides a precision of about 185 kilometers. Once the geographic context is established, as with Universal Transverse Mercator or State Plane coordinates or other zonal system, a set of least significant descriptors as simple as "45.67" can designate a region about 2 kilometers in width within an area about 200 kilometers wide. Likewise when working with a small region, the most significant grid designators can be assumed. The simple descriptor "..67.47" for instance, can refer to a region 200 meters in extent if the geographic context has already been established as within the "US.CA.NWB.45" region. Any time that the current geographic context becomes ambiguous, any of the most significant designators can be prefixed to the coded location until the context is again clear.

Because at any point the designator can be converted to a geodetic latitude and longitude in WGS-84, conversion of location descriptors can be accomplished with reference to MGRS, UTM, SPC, or any other location reference system or map projection coordinates.

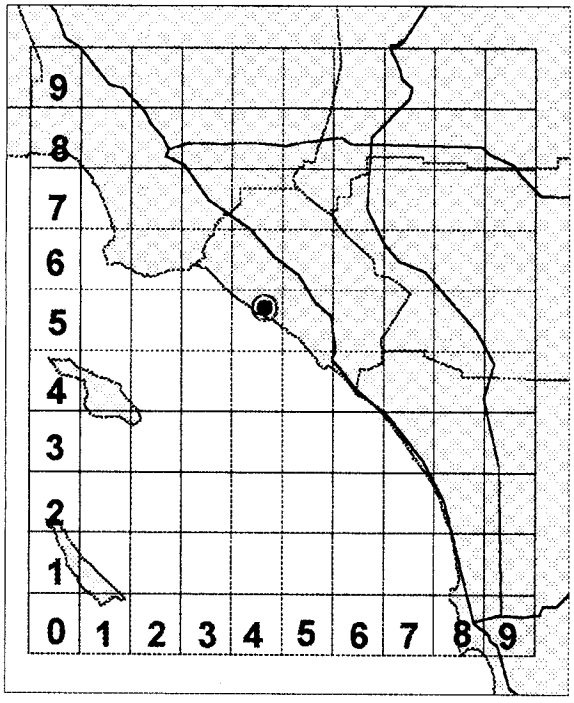
City grids will overlap, so a particular location in an urban area may be identified with reference to various cities. The number of digits in the address will vary depending on the level of accuracy desired for a particular application. Although full Universal addresses always contain a city code, the System uses various methods to virtually eliminate the need to manually input the city code portion of a Universal address.

The structure of the Universal addresses and the city grid is illustrated by the following illustrations. Figure 1 shows a sample city grid for Newport Beach, California, designated by CA.NWB, based on a city grid which is approximately 185 kilometers square. The size of the city grids may vary depending on the size of the city grid for that city and the latitude of the city. The area designated by CA.NWB.45 is indicated by the "45" cell of the grid, and constitutes an area approximately 18.5 kilometers square.

The area designated by CA.NWB.45 is also indicated in Figure 2, which further indicates the area approximately 1,850 meters square referenced by the designation CA.NWB.45.67. An additional level of precision can be obtained by adding an additional pair of designators which are illustrated in Figure 3, which indicates the area of approximately 185 meters square referenced by the designator CA.NWB.45.67.47.

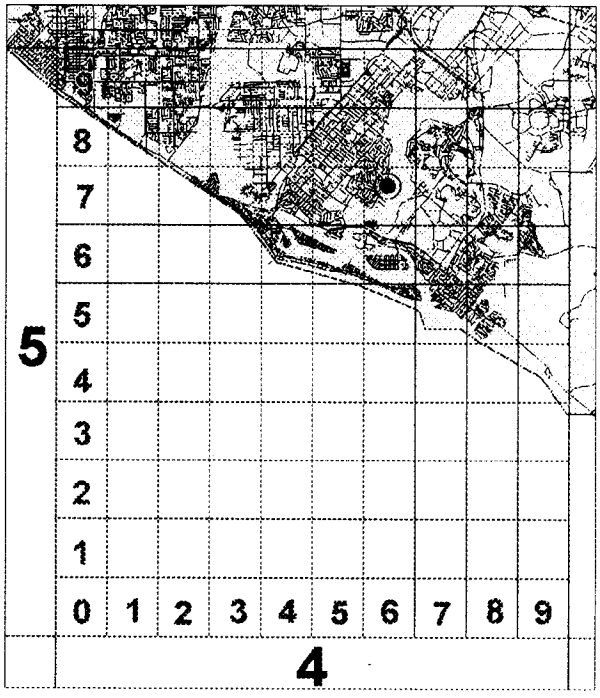
Finally, Figure 4 indicates the area of approximately 18.5 meters square referenced by the designator CA.NWB.45.67.47.52. Although even greater precision can be obtained by additional designators, the use of four pairs of designators will probably provide adequate accuracy for most purposes.

FIGURE 1:



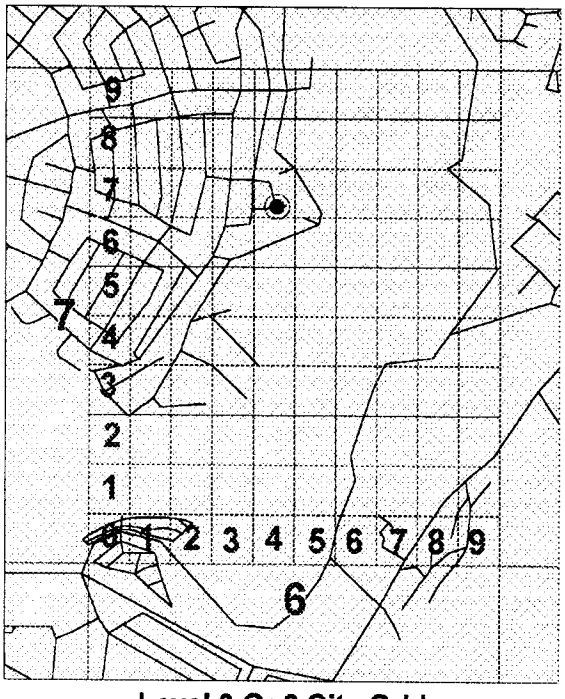
Level 1 Go2 City Grid
Newport Beach, CA
CA.NWB.45

FIGURE 2



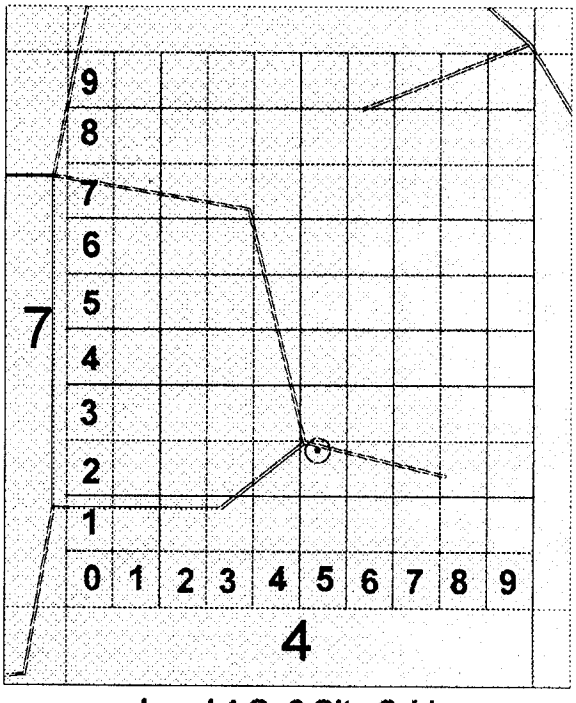
Level 2 Go2 City Grid
Newport Beach, CA
CA.NWB.45.67

FIGURE 3:



Level 3 Go2 City Grid
Newport Beach, CA
CA.NWB.45.67.47

FIGURE 4:



Level 4 Go2 City Grid
Newport Beach, CA
CA.NWB.45.67.47.52

Higher precision can be obtained by reducing the size of the city grid, and the following table indicates the approximate level of precision that can be obtained with varying levels of designators for various sizes of city grids:

FIGURE 5:

CITY GRID ACCURACY CHART

Sample Designator	Approximate Level of Precision		
NWB	185 km	50 km	10 km
NWB.12	18.5 km	5 km	1 km
NWB.12.34	1,850 m	500 m	100 m
NWB.12.34.56	185 m	50 m	10 m
NWB.12.34.56.78	18.5 m	5 m	1 m

Proprietary Addresses

In addition to the Universal addresses determined by the System's algorithms, the System contains a proprietary database of abbreviated identifiers which provide extremely short electronic addresses for specific locations. These addresses are unique for any given location and allow user's to identify destinations with an extremely short address, generally only a four or five digit alpha-numeric number combined with a city code. The following are examples of Proprietary addresses identifying specifically assigned locations:

Ruby's Restaurant on the Balboa Pier	US.CA.NWB.RUBY
Entrance to Disneyland	US.CA.ANA.MIC
The Rose Bowl in Pasadena	US.CA.PSD.ROSE
Hospital in Santa Barbara, California	US.CA.SBA.HP1
Plateau Point at the Grand Canyon	US.GCN.PP
South entrance to the Grand Canyon National Park	US.GCN.SENT

Proprietary addresses will generally bear some mnemonic or other relationship to the location being identified. Proprietary addresses will be coordinated with the city grid system utilized for Universal addresses, so that Proprietary addresses within a particular city grid also contain reference to the city grid for that city. Proprietary addresses will be assigned for many public use areas and locations, including national, state, and local parks, specific tourist attractions and points of interest, hospitals, etc. Proprietary addresses will also be designed to assist the user interpret and/or remember the address.

Map Codes

In addition to Universal and Proprietary addresses used by the System, the System provides a fully integrated method designed to facilitate the use of printed or electronic maps with the System through the use of Map Codes. Map Codes will be assigned and/or determinable by algorithms for any map of any area. Upon the first use of a particular printed map by the user, the System allows users to input or select a Map Code for that particular map, and thereafter the hardware or software will assume that further inputs are within the geographic boundaries of that particular map. This map coding feature of the System allows Universal or Proprietary addresses on a particular map to be extremely short and user friendly. It also minimizes the number of keystrokes necessary to enter a desired destination or location.

As an example of the use of the Map Code features of the System in connection with Universal addresses, consider a map of the area near and including Bryce Canyon, Utah. All of the Universal addresses on that map would begin with the same 5 digits -- BCN.73. Thus, the Bryce Canyon map would utilize BCN.73 as its Map Code, and particular points of interest on the map can then be identified and/or selected as a destination by entering only two to six numbers depending on the level of accuracy desired.

Map Codes can also be used for specific maps and locations utilizing Proprietary addresses. In this context, the use of Map Codes would allow Proprietary addresses with only one alpha numeric digit to identify up to 36 locations on any specific map.

Disadvantages of the Current Consumer Interfaces

Although the standard latitude/longitude coordinate system can be extremely accurate, it is cumbersome, confusing and very poorly understood by the general public. It is also difficult for the non-technical person to understand and use. This can be demonstrated by the fact that many sophisticated users of GPS and other navigation devices, including the military, civilian pilots, boaters, and others, have developed over the years a

variety of alternative interfaces for everyday use. GPS navigation devices relying on traditional latitude/longitude input will provide very little utility for the general public, and the various features of the proposed System will greatly enhance the functionality and ease of use of GPS systems.

GPS units designed for the general public tend to rely on user defined locations, or "waypoints" which are either automatically stored by the GPS unit or manually inputted using the traditional latitude/longitude coordinate system. Manually inputting a location requires the user to determine the latitude/longitude coordinates of a particular location prior to inputting it into the unit. Because it is extremely difficult for the average person to obtain latitude longitude coordinates for most locations, the general public has very limited ability to establish specific locations or waypoints as they plan and/or navigate to that location. Even if they have the ability and means of obtaining latitude/longitude coordinates, the process of obtaining the information and manually inputting it into the GPS unit is relatively time consuming and cumbersome for the average person. Because of the difficulty of inputting locations in traditional latitude/longitude format, electronic navigation devices, particularly simple devices with limited storage capabilities, do not provide the utility desired by the general public.

More sophisticated navigation devices contain extensive databases and digitized street and other maps, and because of the prevalence of traditional street addresses for uses by the general public, street addresses are generally the addressing method of choice for consumer oriented navigation devices. These systems require substantial data storage capabilities, especially if they are intended to cover large geographic areas. Although these systems provide utility to the average consumer, in many situations all the user needs is to 'tell' the navigation device where the user wants to go, and in this context street addresses can be cumbersome. In such situations, the difficulty of searching extensive databases or inputting city and street addresses can be avoided by utilizing the simple Universal address provided by the System. In addition, for applications where minimal input is required for safety or other reasons, e.g. automobile navigation systems, traditional street addresses can require substantial time and/or keystrokes to input. The System eliminates spelling issues, street ambiguity (e.g. Sepulveda Blvd., Lane, Court, etc.) and address numbering ambiguity (3422 N, S, E, or W) and in most cases, it eliminates the necessity of including the city in the location address. These aspects of the System are particular useful for emergency and 911 applications. Finally, the Universal addresses capabilities of the System far exceed the accuracy of traditional street addresses and provide a location reference in any location irrespective of its proximity to a street or other geographic landmark.

Conclusion

While there is certainly no shortage of location referencing systems available for use in electronic navigation, none of the existing systems were designed or are easily adaptable for use by the general public on a day to day basis. The System has been designed to provide the non-technical person with an easy to understand, user-friendly location referencing system with universal coverage and various features designed to maximize the utility of GPS and other electronic navigation devices. The System is not designed to replace, but rather to supplement, existing location referencing systems and provide a user-friendly addressing method for applications where a consumer oriented interface is necessary and important.

Acknowledgments

The Location Referencing System described in this Paper was developed by the authors for Go2 Software, Inc., 5000 Birch Street, Suite 3000 North Tower, Newport Beach, CA 92660, Tel. 714.260.2025. Go2 Software retains all proprietary rights to the System, including any technology and methods which are the subject of the pending U.S. Patent Application No. 08/701,586. Go2 is a trademark of Go2 Software, Inc.

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