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Technical Specification

**Digital cellular telecommunications system (Phase 2+) (GSM);
Universal Mobile Telecommunications System (UMTS);
Universal Geographical Area Description (GAD)
(3G TS 23.032 version 3.0.0 Release 1999)**

GLOBAL SYSTEM FOR
MOBILE COMMUNICATIONS

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Foreword

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3G TS | TR nn.nnn "<title>" (with or without the prefix 3G)

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ETSI TS | TR 1nn nnn "[Digital cellular telecommunications system (Phase 2+) (GSM);] Universal Mobile Telecommunications System; <title>

For GSM document identities of type "GSM xx.yy", e.g. GSM 01.04, the corresponding ETSI document identity may be found in the Cross Reference List on www.etsi.org/key

Contents

Foreword

This Technical Specification has been produced by the 3GPP.

This TS defines an intermediate universal Geographical Area Description within the 3GPP system.

The contents of the present document are subject to continuing work within the TSG and may change following formal TSG approval. Should the TSG modify the contents of this TS, it will be re-released by the TSG with an identifying change of release date and an increase in version number as follows:

Version 3.y.z

where:

x the first digit:

1 presented to TSG for information;

2 presented to TSG for approval;

3 Indicates TSG approved document under change control.

y the second digit is incremented for all changes of substance, i.e. technical enhancements, corrections, updates, etc.

z the third digit is incremented when editorial only changes have been incorporated in the specification;

1 Scope

The present document defines an intermediate universal Geographical Area Description which subscriber applications or GSM services can use and the network can convert into an equivalent radio coverage map.

For GSM services which involve the use of an "area", it can be assumed that in the majority of cases the Service Requester will be forbidden access to data on the radio coverage map of a particular PLMN and that the Service Requester will not have direct access to network entities (e.g. BSC/BTS).

The interpretation by the PLMN operator of the geographical area in terms of cells actually used, cells that are partly within the given area and all other technical and quality of service aspects are out of the scope of the present document.

2 References

The following documents contain provisions which, through reference in this text, constitute provisions of the present document.

- References are either specific (identified by date of publication, edition number, version number, etc.) or non-specific.
- For a specific reference, subsequent revisions do not apply.
- For a non-specific reference, the latest version applies.
- A non-specific reference to an ETS shall also be taken to refer to later versions published as an EN with the same number.

[1] GSM 01.04: "Digital cellular telecommunications system (Phase 2+); Abbreviations and acronyms".

[2] GSM 04.07: "Digital cellular telecommunications system (Phase 2+); Mobile radio interface signalling layer 3 General aspects".

[3] Military Standard WGS84 Metric MIL-STD-2401 (11 January 1994): "Military Standard Department of Defence World Geodetic System (WGS)".

3 Definitions and abbreviations

3.1 Definitions

For the purposes of the present document, the following definitions apply.

Service Requester: Entity, which uses the Geographical Area Description in any protocol to inform the network about a defined area

3.2 Abbreviations

In addition to those mentioned below, abbreviations used in the present document are listed in GSM 01.04.

For the purposes of the present document, the following abbreviations apply:

GAD Geographical Area Description
GPS Global Positioning System
WGS World Geodetic System

4 Reference system

The reference system chosen for the coding of locations is the World Geodetic System 1984, (WGS 84), which is also used by the Global Positioning System, (GPS). The origin of the WGS 84 co-ordinate system is the geometric centre of the WGS 84 ellipsoid. The ellipsoid is constructed by the rotation of an ellipse around the minor axis which is oriented in the North-South direction. The rotation axis is the polar axis of the ellipsoid, and the plane orthogonal to it and including the centre of symmetry is the equatorial plane.

The relevant dimensions are as follows:

Major Axis (a) = 6378137 m

Minor Axis (b) = 6356752,314 m

First eccentricity of the ellipsoid $= \frac{a^2 - b^2}{b^2} = 0{,}0066943800668$

Co-ordinates are then expressed in terms of longitude and latitude relevant to this ellipsoid. The range of longitude is -180° to +180°, and the range of latitude is -90° to +90°. 0° longitude corresponds to the Greenwich Meridian, and positive angles are to the East, while negative angles are to the West. 0° latitude corresponds to the equator, and positive angles are to the North, while negative angles are to the South. Altitudes are defined as the distance between the ellipsoid and the point, along a line orthogonal to the ellipsoid.

5 Shapes

The intention is to incorporate a number of different shapes, that can be chosen according to need. In this version only a minimum number of shapes are described.

- Ellipsoid Point;
- Ellipsoid point with uncertainty circle;
- Polygon.

Each shape is discussed individually.

5.1 Ellipsoid Point

The description of an ellipsoid point is that of a point on the surface of the ellipsoid, and consists of a latitude and a longitude. In practice, such a description can be used to refer to a point on Earth's surface, or close to Earth's surface, with the same longitude and latitude. No provision is made in this version of the standard to give the height of a point.

Figure 1 illustrates a point on the surface of the ellipsoid and its co-ordinates.

The latitude is the angle between the equatorial plane and the perpendicular to the plane tangent to the ellipsoid surface at the point. Positive latitudes correspond to the North hemisphere. The longitude is the angle between the half-plane determined by the Greenwich meridian and the half-plane defined by the point and the polar axis, measured Eastward.

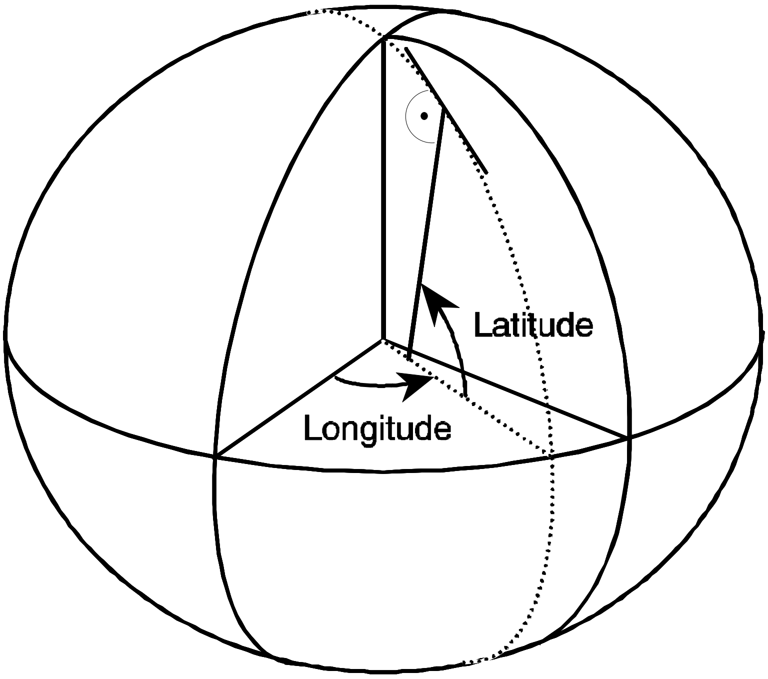

Figure 1: Description of a Point as two co-ordinates

5.2 Ellipsoid point with uncertainty circle

The "ellipsoid point with uncertainty circle" is characterised by the co-ordinates of an ellipsoid point (the origin) and a distance *r*. It describes formally the set of points on the ellipsoid which are at a distance from the origin less than or equal to *r*, the distance being the geodesic distance over the ellipsoid, i.e., the minimum length of a path staying on the ellipsoid and joining the two points, as shown in figure 2.

As for the ellipsoid point, this can be used to indicate points on the Earth surface, or near the Earth surface, of same latitude and longitude.

The typical use of this shape is to indicate a point when its position is known only with a limited accuracy.

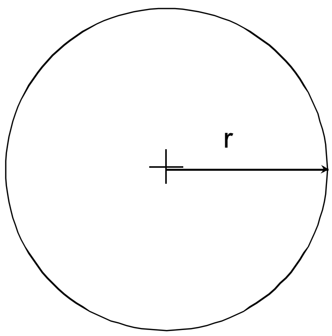

Figure 2: Description of an uncertainty Circle

5.3 Polygon

A polygon is an arbitrary shape described by an ordered series of points (in the example pictured in the drawing, A to E). The minimum number of points allowed is 3, and the maximum number of points allowed is 15. The points shall be connected in the order that they are given. A connecting line is defined as the line over the ellipsoid joining the two points and of minimum distance (geodesic). The last point is connected to the first. The list of points must respect a number of conditions:

- a connecting line shall not cross another connecting line;
- two successive points must not be diametrically opposed on the ellipsoid.

The described area is situated to the right of the lines with the downward direction being toward the Earth’s centre and the forward direction being from a point to the next.

NOTE: This definition does not permit connecting lines greater than roughly 20 000 km. If such a need arises, the polygon can be described by adding an intermediate point.

Computation of geodesic lines is not simple. Approximations leading to a maximum distance between the computed line and the geodesic line of less than 3 metres are acceptable.

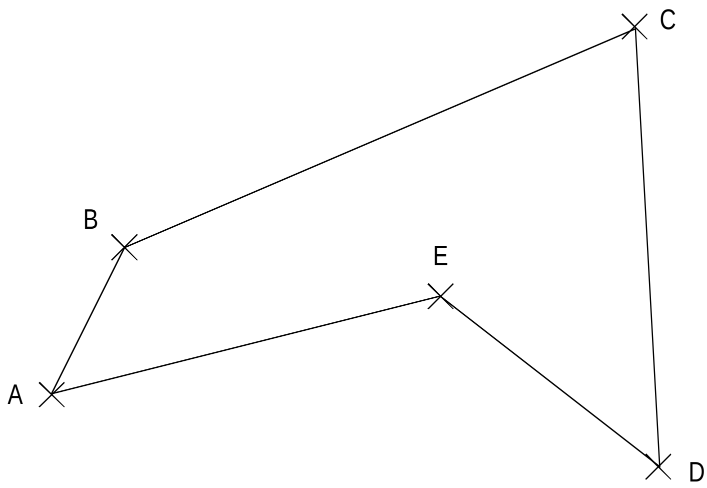

Figure 3: Description of a Polygon

6 Coding

6.1 Point

The co-ordinates of an ellipsoid point are coded with an uncertainty of less than 3 metres

The latitude is coded with 24 bits: 1 bit of sign and a number between 0 and 2^{23}-1 coded in binary on 23 bits. The relation between the coded number N and the range of (absolute) latitudes X it encodes is the following (X in degrees):

$$N \leq \frac{2^{23}}{90} X < N + 1$$

except for N=2^{23}-1, for which the range is extended to include N+1.

The longitude, expressed in the range -180°, +180°, is coded as a number between -2^{23} and $2^{23}-1$, coded in 2's complement binary on 24 bits. The relation between the coded number N and the range of longitude X it encodes is the following (X in degrees):

$$N \leq \frac{2^{24}}{360} X < N + 1$$

6.2 Uncertainty

A method of describing the uncertainty has been sought which is both flexible (can cover wide differences in range) and efficient. The proposed solution makes use of a variation on the Binomial expansion. The uncertainty *r*, expressed in metres, is mapped to a number K, with the following formula:

$$r = C\left((1+x)^K - 1\right)$$

with C = 10 and x = 0,1. With $0 \leq K \leq 127$, a suitably useful range between 0 and 1800 kilometres is achieved for the uncertainty, while still being able to code down to values as small as 1 metre. The uncertainty can then be coded on 7 bits, as the binary encoding of K.

Table 1: Example values for the uncertainty Function

Value of K	Value of uncertainty
0	0 m
1	1 m
2	2.1 m
-	-
20	57.3 m
-	-
40	443 m
-	-
60	3 km
-	-
80	20 km
-	-
100	138 km
-	-
120	927 km
-	-
127	1800 km

7 General message format and information elements coding

This clause describes a coding method for geographical area descriptions. A geographical area description is coded as a finite bit string. In the figures, the bit string is described by octets from top downward, and in the octet from left to right. Number encoding strings start with the most significant bit.

7.1 Overview

A bit string encoding a geographical description shall consist of the following parts:

- Type of Shape;
- Shape Description.

Such a bit string is usually part of an information element. The structure of the information element (e.g., element identifier, length) depends on the protocol in which the message containing the description is defined, and is specified in the protocol specification.

This organisation is illustrated in the example shown in figure 4.

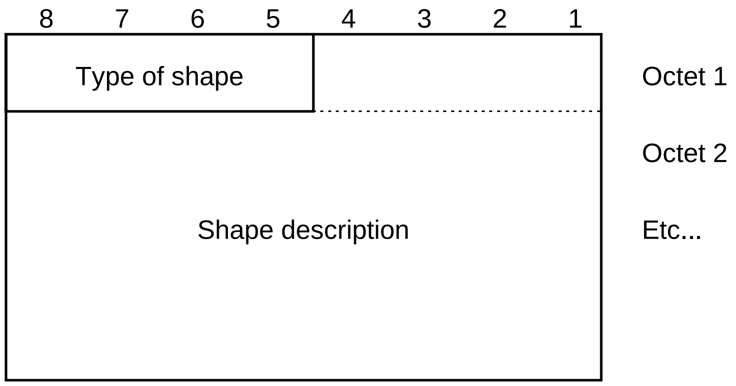

Figure 4: Example

7.2 Type of Shape

The Type of Shape information field identifies the type which is being coded in the Shape Description. The Type of Shape is coded as shown in table 2.

Table 2: Coding of Type of Shape

Bits	
4 3 2 1	
0 0 0 0	Ellipsoid Point
0 0 0 1	Ellipsoid point with uncertainty Circle
0 1 0 1	Polygon
other values	reserved for future use

7.3 Shape description

The shape description consist of different elements.

7.3.1 Ellipsoid Point

The coding of a point is described in figure 5.

8	7	6	5	4	3	2	1	
0	0	0	0	spare				Octet 1
S								Octet 2
Degrees of latitude								Octet 3
								Octet 4
								Octet 5
Degrees of longitude								Octet 6
								Octet 7

Figure 5: Shape description of a point

S: Sign of latitude

Bit value 0 North

Bit value 1 South

Degrees of latitude

Bit 1 of octet 4 is the low order bit

Degrees of longitude

Bit 1 of octet 7 is the low order bit

7.3.2 Ellipsoid Point with uncertainty Circle

8	7	6	5	4	3	2	1	
0	0	0	1	spare				Octet 1
S								Octet 2
Degrees of latitude								Octet 3
								Octet 4
								Octet 5
Degrees of longitude								Octet 6
								Octet 7
0 spare	Uncertainty code							Octet 8

Figure 6: Shape description of an ellipsoid point with uncertainty circle

7.3.3 Polygon

8	7	6	5	4	3	2	1	
0	1	0	1	Number of points				Octet 1
S1								Octet 2
Degrees of latitude of point 1								Octet 3
								Octet 4
								Octet 5
Degrees of longitude of point 1								Octet 6
								Octet 7
Sn								Octet 6n-4
Degrees of latitude of point n								Octet 6n-3
								Octet 6n-2
								Octet 6n-1
Degrees of longitude of point n								Octet 6n
								Octet 6n+1

Figure 7: Shape description of a polygon

The number of points field encodes in binary on 4 bits the number n of points in the description, and ranges from 3 to 15.

Annex A (informative): Element description in compact notation

The notation is the one described in GSM 04.07.

```
<Geographical Area Description> ::=
<Point> |
<Point with uncertainty> |
<Polygon> ;

<Point> : :=
0000 <spare>(4)
<Point co-ordinates> ;

<point co-ordinates> ::=
<Latitude sign : bit> <Unsigned latitude : bit string(23)>
<Longitude : bit string(24)> ;

<Point with uncertainty> ::=
0001 <spare>(4)
<Point co-ordinates>
<spare bit> <Uncertainty: bit string(7)> ;

<Polygon> ::=
0101 <Number of points>
<Point co-ordinates>(val(Number of points)) ;

<Number of points> ::=
0011 | 0100 | 0101 | 0110 | 0111 | 1000 | 1001 | 1010 |
1011 | 1100 | 1101 | 1110 | 1111 ;
```

Annex B: Change history

Change history						
TSG CN#	**Spec**	**Version**	**CR**	**<Phase>**	**New Version**	**Subject/Comment**
Apr 1999	GSM 03.32	6.0.0				Transferred to 3GPP CN1
CN#03	23.032				3.0.0	Approved at CN#03

History

Document history		
V3.0.0	January 2000	Publication