NON-GPS NAVIGATION USING THE METHOD

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Annotatsiya – Hozirda mobil aloqa tizimlarida mobil stantsiyalarning manzillarini aniq aniqlaydigan GPS texnologiyalari yordamisiz ishlash mexanizmlari kuchaytirilishi zarur hisoblanadi. Bu taklifni amalga oshirish uchun ushbu maqolada ishlatiladigan Okamura-Xata va Wolfish-Ikegami usullarini taklif qilamiz. Ushbu ishning maqsadi - GPS vositalaridan foydalanib, kompleks tadqiqotchilarni va nazorat qiluvchi tashkilotlarning ish samaradorligini oshirishdir.

Abstract — Mobile communications must be enhanced by establishing a non-GPS technology that can detect the positions of mobile stations precisely. In this paper, we propose methods of used Okamura-Hata and Wolfish-Ikegami. The purpose of this work is carrying out of complex researchers of features and the supervision organization objects by means of GPS.

Аннотация - Мобильная связь должна быть улучшена за счет внедрения технологии без GPS, которая может точно определять местоположение мобильных станций. В этой статье мы предлагаем методы использования Okamura-Hata и Wolfish-Ikegami. Целью данной работы является проведение комплексных исследований особенностей и организации наблюдения объектов с помощью GPS.

Keywords — GSM, Non-GPS, NLOS, LOS, WIM, BTS, mobile station

INTRODUCTION

In mobile communications, the establishment of very precise mobile station detection technologies is an important goal. Some of the existing technologies utilize only the mobile communication system itself. One example is the cell based mobile location approach. The subject of researchers in mobile systems GSM on Non-GPS navigation. The purpose of this work is carrying out of complex researchers of features and the supervision organization objects by means of GPS.

LITERATURE REVIEW

For achievement of the given purpose, it was necessary to solve following problems:

-To consider types of control mobile systems and to show advantages of application GPS navigation control systems, mobile objects. At carrying out of researches in the given work, it is if results can be used practically for an authentic estimation capacity of supervision mobile objects on GPS and workings out of recommendations. Because of the spent researchers following scientific results are received:

- Features and advantages of application and exact calculation of trajectory GPS by the mobile system and using method tensor are shown a dual network. In the research the cover zone of one basic station two methods - a method the Okamura-Hata and a method Wolfish-Ikegami settles. During calculations, it will be proved that the difference in calculations by the given methods is insignificant. At term performance, it is required to define cover zone BTS of standard GSM, allocated according to the job in regions are Tashkent, using two methods:

Empirical model of a prediction the Okumura-Hata or COST231-Hata, specified in the job;

Model Walfish-Ikegami (WIM);

To compare results of calculation;

The covering cell radius is defined in three directions: the north, the southeast, and the southwest. It is necessary to define also the MS cover zone one of the offered methods (on a choice). On the drawing to specify the configurations of cover zones BTS received by various methods, and the MS cover zone. The height of the antenna a mobile station (MS) is accepted equal 1,5 m.

Table 1

Height suspension antennas BS

Height of rise of antenna BS h BTS, m	40
Standard GSM	1800
Calculation models	COST231- Хата

Table 2

Standard values of parameters BTS and the MS

Designation	The name and unit of measure	Value
PT_x BTS	Capacity of transmitter BTS, dBWt	13
GT_x BTS	Factor transmitting antenna BTS gains, dB	18
$f\,T_x$ BTS	Band of operational frequencies of transmission BTS, MHz	935-960
PR_x BTS	Sensitivity of receiver BTS, dBWt	-138
GR_x BTS	Factor receiving antenna BTS gains, dB	18

fR_x BTS	Band of operational frequencies of reception BTS, MHz	890-915
PT_x MS	Capacity of the transmitter of the MS, dBWt	-3
$G\ T_x$ MS	Factor gains of the transmitting antenna of the MS, dB	0
$f\ T_x$ MS	Band of operational frequencies of transmission of the MS, MHz	890-915
PR_x MS	Sensitivity of the receiver of the MS, dBWt	-104
GRx MS	Factor gains of the receiving antenna of the MS, dBWt	0
fR_x MS	Band of operational frequencies of reception of the MS, MHz	935-960

The lay of land in service area Δh_{BTS} systems of a mobile radio service is defined on a district map taking into account layout of three-sector antenna K730380 in location BTS.

The coefficient of the coordination of the antenna with a wireless signal on polarization (for the transmitter and the receiver) is accepted by the equal

$$\xi_{R_x} = \xi_{T_x} = 0{,}9 \qquad (1)$$

Efficiency of transferring and receiving feeders is accepted by the equal

$$\eta_{FT_x} = \eta_{FR_x} = 0{,}95 \qquad (2)$$

Determination of a cover zone three-sector BTS by means of prediction models, the registration of propagation loss of radio-waves. The basis of territorial planning is made by energetic calculation in which process the architecture of a network and its space coordinates taking into account quality of service and information loading is defined. The given quality of the accepted signal is defined by sensitivity of the receiver. In a general view the transmission equation can be presented as:

$$P_{R_x} = \frac{P_{T_x} \quad \eta_{T_x} \quad G_{AT_x} \quad \xi_{T_x} \quad G_{AR_x} \quad \eta_{R_x} \quad \xi_{R_x}}{L_{\Sigma}} \qquad (3)$$

Where P_{R_x} - capacity of a wireless signal on a receiver input (it is defined by sensitivity of the receiver);

P_{T_x}- Capacity of the transmitter;

η_{T_x}, η_{R_x} - efficiency of transferring and receiving feeders;

G_{AT_x},G_{AR_x} - gain amounts of transferring and receiving antennas;

ξ_{T_x},ξ_{R_x} - coefficients of the coordination of antennas with a wireless signal on polarization;

L_{Σ} - Total attenuation of radio-waves on a route.

Value of capacity of a wireless signal on a receiver input is convenient for expressing in decibels concerning watt. Thus the equation becomes:

$$P_{R_x}(dB/W t) = P_{T_x}(dB/W t) + \eta_{T_x}(dB) + G_{AT_x}(dB) + \xi_{T_x}(dB) + G_{AR_x}(dB) + \eta_{R_x}(dB) + \xi_{R_x}(dB) - L_{\Sigma}(dB) \quad (4)$$

Under this formula it is simple to define the total energetic losses arising on a route of radio propagation

$$L_{\Sigma}(dB) = P_{T_x} + \eta_{T_x} + G_{AT_x} + \xi_{T_x} + G_{AR_x} + \eta_{R_x} + \xi_{R_x} - P_{R_x} \quad (5)$$

For BTS total attenuation of radio-waves on a route is equal:

$$L_{\Sigma BTS}(dB) = P_{T_x}BTS + \eta_{T_x}BTS + G_{AT_x}BTS + \xi_{T_x}BTS + G_{AR_x}MS + \eta_{R_x}MS + \xi_{R_x}MS - P_{R_x}MS = 138,7(dB) \quad (6)$$

For the MS total attenuation of radio-waves on a route is equal:

$$L_{\Sigma MS}(dB) = P_{T_x}MS + \eta_{T_x}MS + G_{AT_x}MS + \xi_{T_x}MS + G_{AR_x}BTS + \eta_{R_x}BTS + \xi_{R_x}BTS - P_{R_x}BTS = 156,7(dB) \quad (7)$$

Let's define total attenuation of radio-waves as losses of propagation for appropriate type of terrain L_C the correction and considering lay of land L_{CLL}:

$$L_{\Sigma} = L_C + L_{CLL} \quad (8)$$

Research methodology

Let's define the correction, considering a lay of land. For this purpose around rough location BTS on a map of the city we select a place which will satisfy simultaneously to following conditions:

In the given operation the three-sector antenna is used, we divide terrain into 3 sectors: sector A- 0º, sector B - 120º, sector C - 240º.

1. From BTS the MS:

$f_0 = 1850\ MHz$

$$a(h_m) = [1,1\ \log(1850) - 0,7]\ 1,5 - [1,56\ \log(1850) - 0,8] = 0,044$$

$$A = A(f_0, h_b, h_m) = 46,3 + 33,9\ \log(1850) - 13,83\ \log(40) - 0,044 = 134,8566 \quad (9)$$

$$B = B(h_b) = 44,9 - 6,55\ \log(40) = 34,40650 \quad (10)$$

$$L_C = A + B \ \log(r) \quad (11)$$

2. From the MS to BTS:

$f_0 = 1750\ MHz$

$$a(h_m) = \quad (12)$$

$$a(h_m) = [1{,}1 \ \log(1750) - 0{,}7] \ 1{,}5 - [1{,}56 \ \log(1750) - 0{,}8] = 0{,}04187$$

$$A = A(f_0, h_b, h_m) = 46{,}3 + 33{,}9 \ \log(1750) - 13{,}83 \ \log(40) - 0{,}04187 = 134{,}0406\text{:} \quad (13)$$

$$B = B(h_b) = 44{,}9 - 6{,}55 \ \log(40) = 34{,}40650$$

$$L_C = A + B \ \log(r) \quad (14)$$

From BTS_0 to the MS

$$\text{At} \quad h = 81; L_{CLL} = \frac{2.5 + 3.5}{2} = 3dB \ \text{-sector A-}0^0 \quad (15)$$

$$\text{At} \quad h = 172; L_{CLL} = \frac{7{,}5 + 10}{2} = 8{,}75dB \ \text{- sector B - } 120^o \quad (16)$$

$$\text{At} \quad h = 142; L_{CLL} = \frac{6 + 8}{2} = 7dB \ \text{- sector C - } 240^o \quad (17)$$

Let's define losses of propagation for appropriate type of terrain:

From BTS_0 to the MS:

$$L_C = L_\Sigma - L_{CLL} = 138{,}7 - 3 = 135{,}7dB \ \text{– Sector A - } 0^o \quad (18)$$

$$L_C = L_\Sigma - L_{CLL} = 138{,}7 - 8{,}75 = 130{,}2dB \ \text{– Sector B - } 120^o \quad (19)$$

$$L_C = L_\Sigma - L_{CLL} = 138{,}7 - 7 = 131{,}7dB \ \text{–Sector C- } 240^o \quad (20)$$

From the MS to BTS:

$$L_C = L_\Sigma - L_{CLL} = 156{,}7 - 3 = 134{,}7dB \ \text{– Sector A - } 0^o \quad (21)$$

Sector A - 0^o:

$$r = 10^{\frac{L_C - A}{B}} = 10^{\frac{135{,}7 - 134{,}8566}{34{,}40650}} = 1{,}058km$$

From BTS_2 to the MS

$$\text{At} \quad h = 136; L_{CLL} = \frac{5 + 7}{2} = 6dB \ \text{- sector C - } 240^o \quad (22)$$

Let's define losses of propagation for appropriate type of terrain:

From BTS_2 to the MS:

$$L_C = L_\Sigma - L_{CLL} = 138{,}7 - 6 = 132{,}7dB \ \text{–Sector C- } 240^o \quad (23)$$

Sector A - 0^o:

$$r = 10^{\frac{L_C - A}{B}} = 10^{\frac{132,7 - 134,8566}{34,40650}} = 0,473km$$

From the MS to BTS:

$$L_C = L_\Sigma - L_{CLL} = 156,7 - 6 = 150,7dB \text{ – Sector C -240º} \qquad (24)$$

$$r = 10^{\frac{L_C - A}{B}} = 10^{\frac{150,7 - 134,8566}{34,40650}} = 2,887km$$

From BTS_3 to the MS

$$\text{At} \quad h = 175; L_{CLL} = \frac{7 + 10,1}{2} = 8,55dB \text{ - sector B - 120º} \qquad (25)$$

Let's define losses of propagation for appropriate type of terrain:

From BTS to the MS:

$$L_C = L_\Sigma - L_{CLL} = 138,7 - 8,55 = 130,15dB \text{ – Sector B - 120º} \qquad (27)$$

Sector A - 0º:

$$r = 10^{\frac{L_C - A}{B}} = 10^{\frac{130,15 - 134,8566}{34,40650}} = 0,727km$$

From the MS to BTS:

$$L_C = L_\Sigma - L_{CLL} = 156,7 - 8,55 = 148,15dB \text{ – Sector B - 120º} \qquad (28)$$

$$r = 10^{\frac{L_C - A}{B}} = 10^{\frac{148,15 - 134,8566}{34,40650}} = 2,434km$$

The model allows estimating attenuation under the formula

$$L_C = 46,3 + 33,9\log(f_0) - 13,83\log(h_b) - a(h_m) + [44,9 - 6,55\log(h_b)]\log r + C \quad (29)$$

Where With - a constant: for average cities and suburbs with moderate vegetation C = 0 and for centers of big cities C = 3.

$h_b = 40$ m- Height of the antenna of basic station

$h_m = 1,5$ m - Height of the antenna of mobile station

Analysis and results

Table 3

Results of calculations of model of Okomura and the Hut

Direction of sector BTS concerning the joint venture, hailstones.	Propagation loss, LP, дБ		The expected distance between BTS and the MS, km			The expected distance between the MS and BTS, km		
	BTS-MS	MS-BTS	BTS_0	BTS_2	BTS_3	BTS_0	BTS_2	BTS_3
Sector C	135,7	134,7	1,058			1,045		
Sector South-estern	130,2		0,732		0,727			2,434
Sector South-east	131,7		0,809	0.473			2,887	

Model of Wolfish-Ikegami (WIM)

Losses of propagation for appropriate type of terrain show that the signal level noticeably fluctuates because of change of height of buildings, width of streets, relief. Therefore, defining cell radius of covering BTS on the model specified in the job, it is necessary to repeat calculation of cell radius of a covering, using model of Wolfish-Ikegami (WIM), found wider application in the field of mobile technologies. Model WIM is used at attenuation calculation in the city environment.

In model WIM distinguish two cases LOS (direct visibility) and NLOS (non-line-of-sight, i.e. in case of indirect visibility). In case of LOS if on a straight line of propagation of a signal from the transmitter and the receiver there are no barrages the WIM-model is described by the equation:

$$L_{LOS} = 42{,}64 + 26\log d_{km} + 20\log f_{MHz}, d_{km} \geq 0{,}02 \quad (30)$$

Losses in a free space:

$$L_{f_s} = 32{,}45 + 20\log d_{km} + 20\log f_{MHz} \quad (31)$$

$$L_{LOS} = L_{f_s} + 10{,}19 + 6\ \log d_{km} = L_{f_s} + 6\ \log(50\ dkm) = L_{f_s} + 6\ \log\left(\frac{d_{km}}{20}\right) \quad (32)$$

The parameters also used in NLOS WIM: h_b - height of the antenna of basic station (40-50 m from the earth); h_m - height of the antenna of the subscriber (1-3 m from the earth); h_B - height of buildings;

$\Delta h_b = h_b - h_B$ - Height of the antenna of basic station from level of roofs; distance between buildings (20-50);

ω - width of streets (it is normal b/2);

Now we consider some variants in case of NLOS WIM.

$\Delta h_b > 0$:

$$L_{NLOS} = 69{,}55 + 38 \log d_{km} + 26 \log f_{MHz} - 10 \log \omega - 9 \log b + 20 \log h_m - 18 \log(1 + h_b) + L_{LOS} \quad (33)$$

$\Delta h_b \le 0, d_{km} \ge 0{,}5$:

$$L_{NLOS} = 69{,}55 + \quad (34)$$

$h_b \le 0, d_{km} < 0{,}5$:

$$L_{NLOS} = 69{,}55 + \quad (35)$$

As a rule, city regions are built up by unequal height buildings. The width of streets and distance between buildings also fluctuate largely. Therefore at calculation on model WIM some conditions are accepted:

The height of one floor in a residential building is accepted equal 3 m;

In one-storied residential buildings the height of a no planar roof is accepted equal 2m;

Distance between one-storied buildings not less than 5 m;

Width of the streets which have been built up with one-storied houses not less 10 m;

The distance between many-storied buildings is accepted equal 20м;

The width of the streets which have been built up with many-storied buildings is accepted region 20 m;

The height of one floor in office educational and etc. a location is accepted regions 3,5 m;

The height of one floor of the industrial enterprise is accepted regions 7,5 m.

Hence, it is necessary to know percent of building of region in which antenna BS, is allocated by buildings of various type. On the basis of it the average height of buildings, average distance between buildings and average width of streets for all regions defined in the job is defined.

Building height on which antenna BS will be allocated, it is not recommended to average. Knowing height of this building and height of position of antenna BS according to the job, it is possible to define h_b - height of the antenna of basic station from level of roofs.

$h_b = 40\,m, h_m = 1{,}5\,m$

$$h_B = \frac{27+27+27+10}{4} = 22{,}75m \quad (36)$$

$$h_b = h_b - h_B = 40 - 22{,}75 = 17{,}25m \quad (37)$$

$b = 24m, \omega = 12m$

LOS:

$$d_{km} = 10^{\frac{L_C - 42{,}64 - 20\ \log f}{26}} \quad (38)$$

NLOS:

$$d_{km} = 10^{\frac{L_C - 69{,}55 - 26\ \log f + 10\ \log\omega + 9\ \log b - 20\ \log h_m + 18\ \log(1 + h_b)}{38}}$$

(39)

From BTS_0 to the MS: $f_0 = 1850MHz$ Sector A - 0º:

LOS:

$$d_{km} = 10^{\frac{135{,}7 - 42{,}64 - 20\ \log f 1850}{26}} = 11{,}641843km$$

NLOS: service station attendant

$$d_{km} = 10^{\frac{135{,}76 - 69{,}55 - 26\log(1850) + 10\log(12) + 9\log(24) - 20\log(1{,}5) + 18\log(1 + 17{,}25)}{38}} = 4{,}2330km$$

From the MS to BTS: $f_0 = 1750MHz$

Sector A- 0º:

$$d_{km} = 10^{\frac{134{,}7 - 69{,}55 - 26\log(1750) + 10\log(12) + 9\log(24) - 20\log(1.5) + 18\log(1 + 21{,}4)}{38}} = 5{,}056km$$

From BTS_3 to the MS: $f_0 = 1850\ MHz$ Sector B - 120º:

LOS:

$$d_{km} = 10^{\frac{130{,}15 - 42{,}64 - 20\ \log 1850}{26}} = 7{,}1529km$$

NLOS:

$$d_{km} = 10^{\frac{130{,}15 - 69{,}55 - 26\log(1850) + 10\log(12) + 9\log(24) - 20\log(1{,}5) + 18\log(1 + 21{,}4)}{38}} = 3{,}0123km$$

From the MS to BTS: $f_0 = 1750\ MHz$

Sector B- 120º:

$$d_{km} = 10^{\frac{148,16 - 69,55 - 26\log(1750) + 10\log(12) + 9\log(24) - 20\log(1.5) + 18\log(1 + 21,4)}{38}} = 10,721\,km$$

From BTS_2 to the MS: $f_0 = 1850\,MHz$ Sector C - 240º:

LOS:

$$d_{km} = 10^{\frac{132,7 - 42,64 - 20\ \log 1850}{26}} = 8,965\,km$$

NLOS:

$$d_{km} = 10^{\frac{132,7 - 69,55 - 26\log(1850) + 10\log(12) + 9\log(24) - 20\log(1.5) + 18\log(1 + 21,4)}{38}} = 3,516\,km$$

From the MS to BTS: $f_0 = 1750\,MHz$

Sector A- 0º:

$$d_{km} = 10^{\frac{150,7 - 69,55 - 26\log(1750) + 10\log(12) + 9\log(24) - 20\log(1.5) + 18\log(1 + 21,4)}{38}} = 12,513\,km$$

Results of calculation we tabulate.

Table 4

Results of calculations of model of Wolfish-Ikegami (WIM)

Direction of sector BTS concerning the joint venture, hailstones.	Propagation loss, LP, дБ		The expected distance between BTS and the MS, km			The expected distance between the MS and BTS, km		
	BTS-MS	MS-BTS	BTS_0	BTS_2	BTS_3	BTS_0	BTS_2	BTS_3
Sector C	135,7	134,7	4,238			5,056		
Sector South-estern	130,2		3,022		7,1529 / 3,012			10,721
Sector South-weast	1131,7		3,309	8,965/ 3,516			12,513	

CONCLUSIONS

Maintenance of reliable and steady functioning of networks of mobile radiotelephone (cellular) communication with the account requirements of information security. Modern radio-electronic equipment GSM represents a difficult complex which structure except most GSM includes a control system of processes in GSM. Now, modern mobile systems it is used for many purposes. This work is devoted one of the types of information technology GPS which give the information from time and a position of investigated objects. Now, this technology is very important because it gives the information on navigation and management of objects and for the definition to people of ways in cities and everywhere where this inquiry is necessary for them. For reliable work GPS, it is necessary to demand much on reliable work of mobile system GSM. Therefore, the research problem of methods of the check of working capacity of mobile GPS object is actuals.

REFERENCES

1. John G Grimes. Global positioning system standard positioning service performance standard 4th Edition September 2008.
2. David. B, Goldstein. Col. Navstar GPS Space Segment/Navigation User Interfaces IS-GPS-200E 8 June 2010
3. Спутниковые навигационные системы 2004 МАИ каф.604
4. Wei Cao. Multi-frequency GPS and Galileo Kinematic Positioning with Partial Ambiguity Fixing February 2009
5. Jiyun Lee. GPS-based aircraft landing systems with enhanced performance:beyond accuracy March 2005
6. J. Eberspächer, H.-J. Vögel, C. Bettstetter and C. Hartmann GSM – Architecture, Protocols and Services Third Edition 2009 John Wiley & Sons, Ltd.
7. А. В. Печаткин. Ссистемы мобильной связи часть 1 Рыбинск 2008
8. Галкин В.А. Цифровая мобильная радиосвязь. Учебное пособие для вузов. – М.:Горячая линия–Телеком, 2007
9. Всеволод Кшиштов. Системы подвижной радиосвязи. Пер. с польского И.Д. Рудинского; под ред. А.И. Ледовского. М.: Горячая линия – Телеком,2006
10. Корпоративный тренинг. Обзор системы GSM. ВымпелКом – 2004