INTERNATIONAL PATENT RESOURCES IN THE STUDY OF INNOVATIVE TECHNOLOGIES (AT THE EXAMPLE OF GLONASS/GPS)

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ABSTRACT

In the work presented by the authors and based on the use of the international patent resource Qustel-Orbit, the state of innovative activity and patenting in the field of satellite navigation GPS-GLONASS was revealed for the entire period of patenting of inventions in the world until 2014. Inventions based on the use of GPS-GLONASS systems have a wide range of practical applications. In the area under consideration, the largest number of patents is published in China, the United States, and Korea. In this row, Russia occupies the eleventh place. The positioning of patent owners was suggested according to the indices of relative similarity and with the stage-by-stage processing of information according to a given algorithm.

Keywords: patent resource Qustel-Orbit, FIPS, innovative technologies, satellite navigation, GPS, GLONASS, system analysis, patent owners.

Background. *Mankind has entered a new era when innovations determine the political, technological, economic strength of states and the quality of life of their citizens. In order that innovations to ensure increased labor productivity and commercial income, it is necessary at the pre-project stage of their creation to conduct system studies in the relevant technological subject area, to identify the general state and direction of innovative technologies development in the world and / or in the territories of individual countries, identify competitors and determine the directions of their activity, to collect information about what technological projects they are working on.*

To solve such problems, innovative organizations around the world actively use international patent resources, since the patent is the first publication that can indicate a possible marketing plan of competitors, and 70–90% of information contained in patent documents is not published anywhere else.

The most complete collection of patents in the world, concentrating information from 67 countries and 37 international patent databases, is contained in the information resource Questel-Orbit [1].

Questel-Orbit is a division of the communications company France Telecom Group, which has been the leader of the information industry for more than twenty years, having a high rating in the field of providing data related to intellectual property and business.

This resource was used by us in researching innovations in the field of satellite navigation systems, which in the foreseeable future that will qualitatively change the situation not only in certain fields of activity, but throughout the world economy.

Objective. *The objective of the authors is to consider international patent resources in research of innovative technologies development, using GPS – GLONASS samples as an example.*

Methods. *The authors use general scientific methods, comparative analysis, statistical method, evaluation approach, graph construction.*

Results.

Analysis of GPS/GLONASS patents operating in the world

The market of global navigation systems is a market of goods and services using location and navigation based on GNSS (Global Navigation Satellite Systems) technologies. Active global satellite systems are GPS (USA), GLONASS (RF), DORIS (France), under construction: BeiDou (China), Galileo (European system).

GNSS is growing rapidly worldwide. The average annual rate of total revenue of the application market was 13% between 2010 and 2016. The global GNSS target market for segments is as follows: road sector – 54%, LBS – 43,7%, agriculture – 1%, surveying – 0,6%, aviation – 0,5%, shipping – 0,1%.

Thus, it can be stated that the bulk of the commercial revenues from space activities falls on telecommunications, television, navigation, etc., which are carried out using spacecraft and equipment installed on them. In this area (Global Navigation Satellite Systems) there is a large number of classes of the International Patent Classification (IPC), representing physics, electronics, information technology and mechanical engineering, so the search on the IPC does not allow selecting documents related to space. In this case, it is advisable to search for information on keywords, for example, GLONASS (GNSS, Global Navigation Satellite System) and GPS (Global Positioning System).

As a result of the query for the keywords «GNSS or GPS», the international patent resource Questel-Orbit issued 74439 documents[1], of which 53817 are valid documents, i.e. 72% of patent documents have legal force. Since all patent resources have limitations on the size of analyzed samples, the resulting set should be truncated, for which the priority date of the document was used – not earlier than 01.01.2004. As a result, 47600 documents were received for the last 10 years (63% of the total), all of which are in force. The dynamics of the publication of information from this sample according to the «five-year plan» is shown in Pic. 1, and Pic. 2, 3 show the leading countries of publication and rights holders.

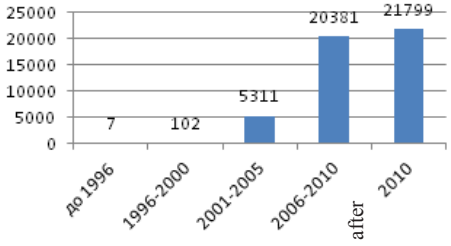
In the area under consideration, the largest number of patent documents is published in China, the United States is in second place, Japan is in the fourth after Korea, and Europe is in the fifth place. Russia occupies the 11th position with the number of publications 725.

The leading right holders are well-known manufacturers of electronics and telecommunications equipment from Korea, Japan and the USA.

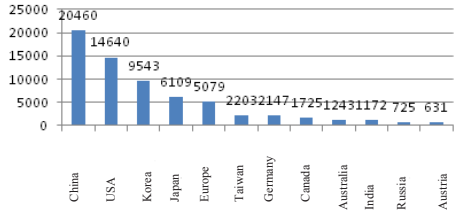
Patents in force in Russia

From the sample of patents in the field of GNSS / GPS with priority after 01.01.2004, 1302 patents were published in Russia (without restriction on the priority date, 1628 documents were found, the analysis was conducted on a sample with a restriction).

[1] All provided values are valid as of 20.06.2014.



Pic. 1. Dynamics of publication of patent documents on GNSS / GPS.



Pic. 2. Countries of publication of patent documents on GNSS / GPS.

The distributions of the patents published in Russia by the date of publication and the date of filing the first application are shown in Table 1. They show an almost exponential growth in the number of publications since 1998, with an annual number of primary applications half the total number of publications.

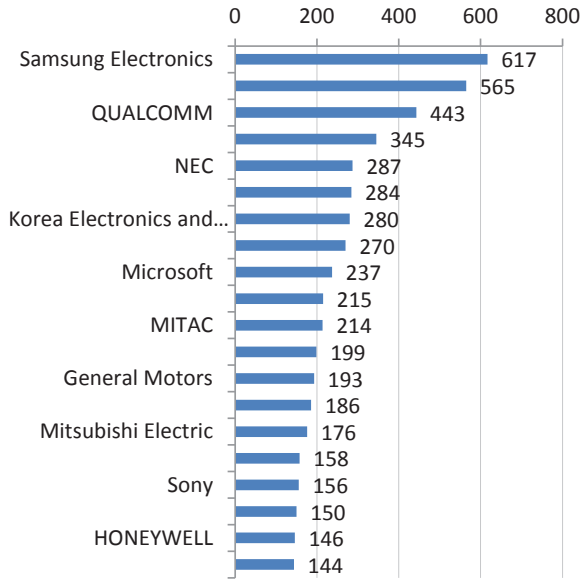
Table 2 shows the distribution of patents by country of publication, from which it can be seen that almost half of the documents have international protection (WO, EP). The ranking by priority countries (Table 3) suggests that almost half of the published patents are foreign, since only 406 documents have priority of Russia (RU). Among the patents with the priority of Russia there are patents of the USA and other countries, which, as a rule, belong to foreign patent owners.

The analysis of leading patent owners in the sample of Russian patents in the field of GPS / GNNS shows that foreign companies are leading in this area. Russian rights holders are relatively weak. Possible reasons may be related to the problem of the names of patent holders, as well as the inclusion of the term GPS in the request. Assuming that the Russian GLONASS navigation system (GNSS) is more relevant for Russian inventors, we made a selection of patents on the key word combination Global Navigation Satellite System (without limitation by priority date, but with restriction on the territory of the Russian Federation) and obtained a sample of 1364 documents. The distribution of these documents by publication date and priority date is presented in Table 4, where it can be seen that active patenting begins at the end of the 1990s and has an exponentially increasing trend, and the annual number of publications almost coincides with the number of primary applications, which leads to the idea of their domestic origin. Tables 5 and 6 show the distribution of patent documents for the country of publication and the country of priority (origin) and confirms the hypothesis put forward, since out of the entire set, only 38 documents have priority in the USA, 9 in Europe, 8 in France, and so on. There are more patent publications in these and other countries, in particular in the United States, 61 patents, Europe – 68, China – 52.

Leading patent holders in the field of GNNS (GLONASS) on the territory – Moscow State Institute of Electronic Technology with 29 documents (without international protection), QUALCOMM (USA) with 22 patents, JSC Russian Railways with 18 patents of the Russian Federation, Russian Institute of Radio Navigation and Time (14 patents of the Russian Federation), the Open Russian Corporation for Rocket and Space Instrument Engineering (13 patents of the Russian Federation).

Analysis of technology patenting areas

In this section, the leading (with the greatest number of patents) subclasses, groups and subgroups of the IPC have been identified, in which inventions aimed at the application of GPS and GLONASS systems are patented. The analysis was carried out on territorial samples of patents received on requests with the keywords GLONASS, GNSS and GPS. Since detailed analysis is possible on a sample of not more



Pic. 3. Leading right holders of patent documents on GNSS / GPS.

Table 1

Distribution of GNSS / GPS patents by the date of publication and the date of the first application

Date	Number of patents		Date	Number of patents	
	by date of publication	by date of the first application		by date of publication	by date of the first application
1998	0	2	2006	91	39
1999	4	6	2007	117	62
2000	6	14	2008	137	70
2001	15	9	2009	191	87
2002	22	13	2010	230	121
2003	26	20	2011	285	122
2004	47	42	2012	285	95
2005	74	36	2013	258	43

Table 2

Distribution of GPS / GNSS patents by country of publication

Country of publication	RU	US	WO	EP	CN	JP	CA	IN	AU	KR	BR	MX	DE	TW	AT
Number of patents	711	337	334	327	297	227	218	190	187	163	108	95	84	75	66
Country of publication	ES	IL	ZA	NO	DK	AR	NZ	PT	SG	HK	GB	FR	SE	HU	RL
Number of patents	56	49	28	27	24	23	23	20	17	17	14	8	8	7	7

Table 3

Distribution of GPS / GNSS patents by country of priority

Country of priority	RU	WO	OS	EP	DE	JP	KR	GB	AU	SE	FR	CN	IT	CA
Number of patents	406	324	214	58	35	20	18	15	14	9	7	6	5	5
Country of priority	BR	FI	NL	HU	NZ	AT	SG	LU	RT	TW	PL	ES	NO	CH
Number of patents	3	3	2	2	2	2	1	1	1	1	1	1	1	1

than 15000 documents, we have examined separately the samples of patents in the field of GNSS / GPS, published in different countries (in particular, Russia, China, the USA) and the world.

The total number of patents in leading subclasses is 1187 (sample size is 1364 documents). These subgroups are part of three sections of the IPC:

Section B – Various technological processes; Transportation (117 documents);

Section G – Physics (820 documents);

Section H – Electricity (250 documents).

The greatest number of patents is contained in the following subclasses and subgroups.

Subclasses:

G01S – Direction-finding; Radio navigation; Measuring distance or speed using radio waves; Locating or detecting objects using reflection or reradiation of radio waves; Similar systems using other types of waves (518 patents).

H04B – Signaling (170 patents).

G01C– Measurement of distances, horizons or azimuths; topography; navigation; Gyroscopic instruments; Photogrammetry or videogrammetry (92 patents).

G08B – Signaling devices or call devices; Command telegraph apparatus; Alarm system (63 patents).

B61L – Traffic control on railways; Safety equipment in railway transport (55 patents).

Subgroups:

G01S-19/00 – Satellite radio navigation positioning systems; Position, velocity or angular spatial position using signals transmitted by such systems (88 patents).

G01S-1/00 – Beacons and beacon systems that emit signals with characteristics that allow them to be detected by non-directional receivers and determine the directions and positions fixed relative to the beacons; Receivers for these systems (68 patents).

G01S-5/00 – Determination of the position by comparing two or more directions in one coordinate system; Positioning by comparing two or more distances in one coordinate system (54 patents).

G01S-5/14 – Definition of absolute distances to several spaced points with a known location (65 patents).

G01S-5/02 – Position determination using radio waves (64 patents).

H04B-7/26 – Radio communication systems, i.e. Systems using radiation for communication between two or more stations, of which at least one mobile (50 patents).

G08B-25/10 – Alarm systems with the transmission to the central station of signals that determine the location of the point at which the conditions that triggered the alarm have occurred, for example fire or police telegraph systems using radio communication systems (48 patents).

Table 7 shows the presence of patents in subgroups for the three samples studied: 1 – by the keyword GLONASS (1364 documents, all patents published in the Russian Federation); 2 – sampling by keywords GNSS or GPS in the territory of the Russian Federation; 3 – sampling by keywords GNSS or GPS in the United

Table 4

Distribution of GLONASS patents by publication date and priority date

Date	Number of patents		Date	Number of patents	
	by date of publication	by date of priority		by date of publication	by date of priority
1994	0	3	2004	38	39
1995	1	9	2005	60	63
1996	7	10	2006	66	75
1997	10	9	2007	77	111
1998	16	12	2008	98	120
1999	13	24	2009	151	126
2000	24	25	2010	183	191
2001	24	27	2011	218	240
2002	29	30	2012	237	205
2003	31	33	2013	244	52

Table 5

Distribution of GLONASS patents by country of publication

Country of publication	RU	WO	US	EP	CN	JP	CA	IN	KR	AU	TW	DE	ES	BR	AT
Number of patents	1349	90	61	58	52	39	39	37	26	24	18	18	13	13	10
Country of publication	MX	FR	EA	IL	HK	NZ	PT	DK	SG	HR	ZA	AR	MY	NO	SE
Number of patents	9	8	6	6	4	3	3	2	1	1	1	1	1	1	1

Table 6

Distribution of GLONASS patents by priority countries

Country of priority	RU	WO	US	EP	FR	DE	CA	EA	JP	AU	SE	GR	KZ
Number of patents	1293	70	38	9	8	4	4	3	2	2	2	2	1

States. The decoding of the patent classes from Table 7 can be found in the patent database of the Federal Institute of Industrial Property (FIPS) [2].

The empty cells in Table 7 can be considered as potential technological (and commercial) niches. For example, in Russia there are 20 patent publications in subgroup B60R-25/00 (Vehicle equipment for preventing or detecting unauthorized use or theft of vehicles) with the use of GLONASS, and in the United States there are no such patents, and therefore, there is an opportunity to seize this niche.

We estimate how similar the leading subgroups of patents for each of the territories are to each other. We will define three classes of subgroups of patents. The first class «GLONASS» comprises leading subgroups of patents from the corresponding sample, the second and third classes are the leading subgroups of patents from GNSS / GPS samples published in the territories of the Russian Federation and the USA (classes GNSS / GPS RF and GNSS / GPS USA). For the analysis of classes, two types of signs are used: qualitative – the names of subgroups and quantitative – the names of subgroups and the number of patents in subgroups. Matrices of similarity of the classes considered, constructed for qualitative and quantitative characteristics using the Chekanovsky-Serensen similarity measure [3], are illustrated in Table 8:

On qualitative grounds, the GNSS / GPS RF and GNSS / GPS USA classes are the most similar (0,58), the less similar are GLONASS and GNSS / GPS USA (0,30). The GLONASS and GNSS / GPS RF classes (0,514) show the greatest similarity in terms of quantitative characteristics, while the lowest is observed between the classes GLONASS and GNSS / GPS USA (0,072). A significant difference in the composition of patent subgroups in Russia and the US can suggest promising directions for development and take decisions on the international protection of domestic inventions abroad.

The analysis of the dynamics of the patenting of leading subgroups in the United States from 2000 to 2014 made it possible to identify the most promising subgroups (with the largest number of patents) over the past five years (2009–2013):

G01S-19/00 – Satellite radio navigation positioning systems; Position, velocity or angular spatial position using signals transmitted by such systems;

G01C-21/00 – Navigation; Navigation instruments;

H04W-4/00 – Services or features specifically designed for wireless communication networks;

H04W-4/02 – Services provided at the location of users or terminals;

H04W-24/00 – Control, monitoring or testing devices;

H04W-64/00 – Determine the location of users or terminals for network management, for example, mobile management;

G06F-15/00 – Digital computers in general;

G06F-15/16 – Combination of two or more computers, each of which is equipped with at least an arithmetic device, a software device and a register, for example for simultaneous processing of several programs;

Table 7

Comparative analysis of the leading IPC subgroups for patents in the samples GLONASS, GNSS / GPS (RF) and GNSS / GPS (USA)

Leading subgroups, included in top-50	Type of search query			Leading subgroups, included in top-50	Type of search query		
	GLONASS	GNSS/ GPS в РФ	GNSS/ GPS in the USA		GLONASS	GNSS/GPS in RF	GNSS/ GPS in the USA
	Number of patents				Number of patents		
B60R25/00	20			G06F 17/00		29	924
B61K 9/08	12			G06F 17/30		19	773
B61L 25/00	33	19		G06F 17/50			849
B61L 25/02	12			G06F 19/00	11	37	
B61L 25/04	10			G06K 9/00			342
B63G 8/00	19			G06Q 10/00			478
B64G 1/00	11			G06Q 30/00			599
G01C21/00	36	71	1608	G06Q 50/00			310
G01C21/24	19			G07C5/00	14	17	
G01C21/26		25	452	G07C5/08	12		
G01C21/28		20	285	G08B1/00			385
G01C21/32		15		G08B1/08			486
G01C21/34		22	442	G08B21/00			303
G01C21/36		15	314	G08B25/00	15		
G01C23/00	37			G08B25/10	48	22	
G01S1/00	68	65	1053	G08G 1/00		14	365
G01S1/02	12			G08G 1/01	16		
G01S5/00	54	29	409	G08G 1/123	28	22	288
G01S5/02	64	42	517	G09B29/00		17	
G01S5/14	65	72	746	G09B29/10		17	
G01S13/00	24			G09G 5/00			269
G01S15/00	10			H01Q 1/00	10		
G01S19/00	88	88	1947	H01Q 1/38	11		
G01S19/01	13	15		H04B1/00	14	15	367
G01S19/05		18		H04B1/06	15		
G01S19/07	11			H04B1/38	21	19	328
G01S19/12		15		H04B7/00	32	25	443
G01S19/13	22			H04B7/185	38	24	310
G01S19/14	14	16		H04B7/26	50	45	339
G01S19/24	12			H04L 12/28		17	272
G01S19/25	17	31	286	H04L 29/06			314
G01S19/33	20	15		H04L 29/08			289
G01S19/42	12	22	401	H04M 1/00		27	601
G01S19/46		18		H04M 3/42			340
G01S19/48		15	347	H04M 11/00	12	18	284
G01S21/26		25		H04M 11/04			296
G01V 1/00		14		H04N7/18			362
G01V 1/38	15			H04W 4/00			1155
G01V 9/00	12			H04W 4/02		32	1020
G01W 1/00	13			H04W 24/00		28	996
G05D1/00	14	15		H04W 48/00		20	
G06F 3/00			384	H04W 56/00		17	
G06F 7/00			462	H04W 64/00	25	56	781
G06F 13/00	12			H04W 88/00		23	460
G06F 15/00			506	H04W 88/02		16	346
G06F 15/16			673	H05K 1/00	11		
				H05K 3/46	11		

Table 8

Matrices of similarity

Qualitative signs			
classes	GLONASS	GNSS/ GPS RF	GNSS/GPS USA
GLONASS	1	0.46	0.3
GNSS OR GPS RF	0.46	1	0.58
GNSS OR GPS USA	0.3	0.58	1

Quantitative signs			
classes	GLONASS	GNSS/ GPS RF	GNSS/ GPS USA
GLONASS	1	0.514	0.045
GNSS OR GPS RF	0.514	1	0.072
GNSS OR GPS USA	0.045	0.072	1

G06F-17/00 – Devices or methods of digital computing or data processing specifically designed for specific functions;

G06F-17/30 – Information search; Database structures for this purpose;

G06F-19/00 – Devices or methods for digital computing or data processing for special applications;

G06Q-30/00 – Trade, such as shopping or e-commerce.

The analysis of patent groups revealed 68 leading groups in the samples studied. At the same time, groups that are absent in the territory of Russia are found, but are represented in the patent samples of other countries. Such groups are few in number, and most of them are related to electronics and information technology. The analysis allows to see the most current trends and competing countries, identify areas that are patented primarily in one country (for example, in group G05B19 (Program Management Systems) of 999 patents in the world sample 858 are published in China and do not fall into the top 50 patent groups in the samples for Russia and the USA).

The most promising in the US subclasses of the IPC (with the largest number of patent publications over the past twenty years) are as follows:

G06F – Digital data processing by electrical devices;

G01S – Direction-finding; Radio navigation; Measuring distance or speed using radio waves; Locating or detecting objects using reflection or reradiation of radio waves; Similar systems using other types of waves;

H04W – Wireless communication networks;

G01C– Measurement of distances, horizons or azimuths; topography; navigation; Gyroscopic instruments; Photogrammetry or videogrammetry;

H04B – Transmission of signals;

G06Q – Data processing systems or methods specifically designed for administrative, commercial, financial, managerial, supervisory or prognostic purposes; Systems or methods specifically designed for administrative, commercial, financial, managerial, supervisory or prognostic purposes not provided for in other subclasses;

H04M – Telephone communication;

H04L – Transmission of digital information, e.g. telegraph communication;

G08B – Signaling devices or call devices; Command telegraph apparatus; Alarm systems;

G08G – Vehicle traffic control systems;

H04N – Image transmission, e.g. television;

G06K – Data Recognition; Data representation; Data reproduction; Manipulation of information carriers; information carriers.

Conclusions.

1. The international patent resource Qustel-Orbit allowed to reveal the state of innovative activity and patenting in the sphere of satellite navigation GPS-GLONASS for the entire period of patenting of inventions in the world until 2014. It was established that 74439 patent documents were issued, of which 53817 (72% of the total number of patents issued for the entire period) are in force today (have legal effect).

2. Dynamics of publications of patents in the field of GPS-GLONASS has an increasing trend. Inventions based on the use of satellite navigation systems have a wide range of practical applications. In the territory of the Russian Federation, such systems are used in 63 fundamentally different areas.

3. In the area under consideration, the largest number of patents is published in China, the United States, and Korea. Russia occupies the eleventh position in this row.

4. The leading right holders are manufacturers of electronics and telecommunications equipment from Korea, Japan, the United States.

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Article received 26.08.2016, accepted 30.10.2016.

The work was carried out with the financial support of the Russian Humanitarian Science Foundation, project No. 16–02–00743 «Multicriterial analysis and forecasting of technical and economic conditions and development trends of the world's leading aerospace companies».