# An assessment of the character and usefulness of the information available on the internet about state-owned satellite navigation and satellite-based augmentation systems

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**Abstract**
To date, a ship's position can generally be obtained from functional satellite navigation systems (SNS), such as Global Position Systems (GPS and GLONASS), and Satellite-Based Augmentation Systems (SBAS), such as (European Geostationary Navigation Overlay Service (EGNOS), GPS-Aided Geo Augmented Navigation system (GAGAN), MTSAT Satellite Augmentation System (MSAS) and Wide Area Augmentation System (WAAS). Sometimes these systems are collectively called Global Navigation Satellite Systems (GNSS). Two more SNS, Galileo and BeiDou, one more SBAS, System for Differential Corrections and Monitoring (SDCM), and new regional systems, such as Quasi-Zenith Satellite System (QZSS) in Japan and Indian Regional Navigation Satellite System (IRNSS) in India, are also under construction. Information about all of these 11 systems is available on the internet. The number of links and the type of the information obtained from two search engines, Google and Bing, for the different keywords concerning each system are shown in the paper. Additionally, the analysis of the character and usefulness of the information placed on the pages of governmental organizations and institutions administering the above-mentioned systems, manufacturers of the satellites, receivers and different kinds of the institutional users is also provided.

## Introduction

Nowadays information about a ship's position is generally obtained from specialized electronic positioning systems, in particular, global satellite navigation systems (SNS) such as global positioning systems (GPS and GLONASS) for position determination by appropriate receivers using Global Navigation Satellite Systems (GNSS) signals, and Satellite-Based Augmentation Systems (SBAS), such as European Geostationary Navigation Overlay Service (EGNOS), Wide Area Augmentation System (WAAS), MTSAT Satellite Augmentation System (MSAS) and GPS-Aided Geo Augmented Navigation system (GAGAN) for improvement of positioning by additional use of corrections and integrity information provided by augmentation service. More SNS (Galileo in Europe and BeiDou in China) and SBAS (SDCM in Russia and two regional systems, the Indian Regional Navigation Satellite System (IRNSS) and Quasi-Zenith Satellite System (QZSS) in Japan) are now also under construction (Munich, 2009–2012, 2014–2015; Januszewski, 2012, 2014; Gibbons, 2013; beidou.gov.com; glonass-center.ru; gps.gov; gpsworld.com; insidegnss.com).

Information about all these 11 systems can be found in different sources, including the internet, which is practically available for everybody anywhere in the world. The character and usefulness of the information concerning each system are presented in this paper. Additionally, the notion of SBAS as the 12th system has been taken into account. In this study we address the following issues:

– how many links relate to each system?

– must the keyword consist of the name of the system only, or its combination with the word "system"?
– what kind of information is in the first 10 links for the chosen keyword?
– how useful is the information in the first 10 links about the given system only?

## The character of the information from search engines Google and Bing

In order to make the quantitative and qualitative analysis of information about the above-mentioned systems two well known search engines, Google and Bing, were used. The number of links $N_L$ for all 12 systems and for each search engine are presented in Table 1. As this number depends on the keyword for each system three keywords were used: No. 1 – the name of the system only, e.g. GPS; No. 2 – the name of the system and the word "system", e.g. GPS system; No. 3 – the word "system" and the name of the system, e.g. system GPS. In the case of some links in which the information doesn't apply directly to the system, an additional table was made. In Table 2 the kind of the information, S – about the system ($N_S$ – number of links), O – other ($N_O$ – number of links), for the first 10 links for each of the keywords of all 12 systems and for each engine is shown. The number of links changes incessantly with time, that is why both tables were made on the same day, April 21, 2015. We can recapitulate that:

• for both engines and for all 12 systems the largest and the lowest number of links $N_L$ is for keyword GPS – 636 million (Google) and keyword QZSS system – 34,200 (Bing), respectively;
• for the same keyword the number $N_L$ is greater for Google than for Bing in the majority of cases, sometimes considerably, e.g. for keyword EGNOS more than 25 times;
• for Google, for all 12 systems the biggest number $N_L$ is for one word keyword (No. 1); for Bing in the case of many systems the number of links for keyword No. 2 was greater than for keyword No. 1, sometimes considerably, e.g. SDCM system – 4,020,000, SDCM – 85,300;
• for both engines and for the majority of the systems, the number $N_L$ for keyword No. 3 is in some cases equal or less, sometimes considerably, than for keyword No. 2, e.g. for Bing, system SBAS – 75,000, SBAS system – 2,390,000;
• in the case of all 4 global NSS for both search engines for all keywords the number $N_L$ is greater for GPS system than for GLONASS system, and greater for Galileo than for BeiDou, in both cases considerably;
• in the case of all 5 SBAS the biggest $N_L$ is for keyword EGNOS (Bing) – 4,700,000, the lowest for keyword system SDCM (Google) – 44,600, for two regional systems (IRNSS and QZSS) the number $N_L$ is, for all three keywords, in the majority of the cases, less than for all other systems;
• the numbers $N_S$ and $N_O$ depend on the system and additionally on the keyword;
• for the same keyword the numbers $N_S$ and $N_O$ differ in both search engines;
• in the majority of the cases the number $N_S$ for the same keyword is greater than the number $N_O$, the $N_S$ is for IRNSS equals 10 for both search engines, for BeiDou, SBAS, EGNOS and QZSS for Google only;

**Table 1. The number of links for different keywords and different search engines (21.04.2015)**

| Keyword | Google | Bing |
|---|---|---|
| GPS | 636 million | 63 million |
| GPS system | 208 million | 134 million |
| system GPS | 207 million | 138 million |
| GLONASS | 11 million | 2,010,000 |
| GLONASS system | 806 000 | 927,000 |
| system GLONASS | 833 000 | 1,040,000 |
| Galileo | 49,900,000 | 5,820,000 |
| Galileo system | 34,100,000 | 3,030,000 |
| system Galileo | 34,100,000 | 2,870,000 |
| BeiDou | 647,000 | 494,000 |
| BeiDou system | 413,000 | 169,000 |
| system BeiDou | 413,000 | 170,000 |
| IRNSS | 329,000 | 187,000 |
| IRNSS system | 144,000 | 59,200 |
| system IRNSS | 141,000 | 59,800 |
| SBAS | 503,000 | 227,000 |
| SBAS system | 355,000 | 2,390,000 |
| system SBAS | 355,000 | 75,000 |
| EGNOS | 4,700,000 | 186,000 |
| EGNOS system | 356,000 | 94,200 |
| system EGNOS | 351,000 | 93,900 |
| WAAS | 8,600,000 | 2,210,000 |
| WAAS system | 551,000 | 809,000 |
| system WAAS | 541,000 | 813,000 |
| MSAS | 539,000 | 587,000 |
| MSAS system | 404,000 | 2,870,000 |
| system MSAS | 404,000 | 148,000 |
| SDCM | 322,000 | 85,300 |
| SDCM system | 66,800 | 4,020,000 |
| system SDCM | 66,800 | 44,600 |
| GAGAN | 10,600,000 | 1,420,000 |
| GAGAN system | 540,000 | 202,000 |
| system GAGAN | 499,000 | 201,000 |
| QZSS | 355,000 | 90,700 |
| QZSS system | 123,000 | 34,200 |
| system QZSS | 123,000 | 32,300 |

- in the case of GPS, Galileo, SDCM and GAGAN for both search engines, for keyword No. 1, the number $N_S$ is less or equal to $N_O$, e.g. for Galileo these numbers are 3 and 7 (Google) and 2 and 8 (Bing), respectively;
- the biggest $N_S$ is for keyword No. 3, for Google for all systems, for Bing in the majority of cases.

**Table 2. The kind of information for the first 10 links for different search engines and different keywords, S – information about the system, O – other information (21.04.2015)**

| Keyword | Google | | Bing | |
|---|---|---|---|---|
| | S | O | S | O |
| GPS | 3 | 7 | 2 | 8 |
| GPS system | 6 | 4 | 3 | 7 |
| system GPS | 6 | 4 | 1 | 9 |
| GLONASS | 7 | 3 | 9 | 1 |
| GLONASS system | 8 | 2 | 10 | 0 |
| system GLONASS | 10 | 0 | 10 | 0 |
| Galileo | 3 | 7 | 2 | 8 |
| Galileo system | 9 | 1 | 8 | 2 |
| system Galileo | 9 | 1 | 9 | 1 |
| BeiDou | 10 | 0 | 9 | 1 |
| BeiDou system | 10 | 0 | 10 | 0 |
| system BeiDou | 10 | 0 | 10 | 0 |
| IRNSS | 10 | 0 | 10 | 0 |
| IRNSS system | 10 | 0 | 10 | 0 |
| system IRNSS | 10 | 0 | 10 | 0 |
| SBAS | 10 | 0 | 7 | 3 |
| SBAS system | 10 | 0 | 8 | 2 |
| system SBAS | 10 | 0 | 10 | 0 |
| EGNOS | 10 | 0 | 9 | 1 |
| EGNOS system | 10 | 0 | 10 | 0 |
| system EGNOS | 10 | 0 | 10 | 0 |
| WAAS | 8 | 2 | 7 | 3 |
| WAAS system | 10 | 0 | 9 | 1 |
| system WAAS | 10 | 0 | 10 | 0 |
| MSAS | 8 | 2 | 5 | 5 |
| MSAS system | 10 | 0 | 5 | 5 |
| system MSAS | 10 | 0 | 9 | 1 |
| SDCM | 3 | 7 | 2 | 8 |
| SDCM system | 10 | 0 | 0 | 10 |
| system SDCM | 10 | 0 | 6 | 4 |
| GAGAN | 5 | 5 | 3 | 7 |
| GAGAN system | 10 | 0 | 10 | 0 |
| system GAGAN | 10 | 0 | 10 | 0 |
| QZSS | 10 | 0 | 10 | 0 |
| QZSS system | 10 | 0 | 10 | 0 |
| system QZSS | 10 | 0 | 9 | 1 |

## Information about the system in the first ten links

In order to analyse the information for each system, the keyword for which the number of links about the system $N_S$ was the biggest was taken into account. If this number was less than 10 (Table 2) the missing links were selected from the second or, if necessary, from the third ten. As this information is from different sources we can distinguish six categories or types of pages:

- encyclopedic, such as astronautix.com, navipedia.net, wikipedia.org;
- producers, such as boeing.com, garmin.com, spirent.com;
- governmental, such as beidou.gov.cn, glonass-center.ru, gps.gov;
- institutional, such as gpsworld.com, insidegnss.com, oosa.unvienna.org;
- private, such as gpsnawi.prv.pl, gps.wroclaw.pl, technologiagps.org.pl;
- web portal, such as geoforum.pl, kowoma.de, nasaspaceflight.com.

The number of links $N_L$ for each type of page for all 12 systems is presented in Table 3. We can say that:

- the distribution of 10 links according to the six above-mentioned page types depends on the system, the number $N_L$ changes between 0 and 5;
- the page types for which the total number $N_L$ for all systems is the biggest and the lowest are web portal (39) and the producers' pages (7) respectively;
- for SBAS system, and for this system only, each page type has at least one link, for two SBAS (EGNOS and SDCM) and one regional (QZSS) two page types (producers and private) are without links, all other systems have one page with $N_L = 0$;
- for seven of the systems the producers' page type has the most instances in which the number $N_L$ equals zero;
- for two page types, encyclopedic and web portal, the number $N_L$ is greater than zero for all 12 systems.

**Table 3. The types of pages with the first 10 links about the system (25.04.2015)**

| Keyword | The number of links for different types of pages | | | | | |
|---|---|---|---|---|---|---|
| | encyclopedic | of producers | governmental | institutional | private | web portal |
| GPS system | 1 | 3 | 2 | 2 | 0 | 2 |
| GLONASS system | 1 | 0 | 2 | 1 | 2 | 4 |
| Galileo system | 1 | 0 | 1 | 3 | 2 | 3 |
| BeiDou | 3 | 1 | 1 | 0 | 1 | 4 |
| IRNSS | 2 | 0 | 1 | 1 | 1 | 5 |
| SBAS system | 2 | 1 | 1 | 2 | 2 | 2 |
| EGNOS system | 2 | 0 | 1 | 4 | 0 | 3 |
| WAAS system | 2 | 1 | 2 | 1 | 0 | 4 |
| MSAS system | 2 | 1 | 0 | 2 | 1 | 4 |
| SDCM system | 2 | 0 | 2 | 4 | 0 | 2 |
| GAGAN system | 1 | 0 | 3 | 1 | 2 | 3 |
| QZSS | 2 | 0 | 2 | 3 | 0 | 3 |
| Total | 21 | 7 | 18 | 24 | 11 | 39 |

In order to analyse the usefulness of each page, five kinds of information were distinguished:

- topicality;
- access;
- reliability;
- historical review;
- principle of the work.

For each above-mentioned kind of information the usefulness of that information was rated in a six-point scale: 0 – lack of information, 1 – very limited information, 2 – limited information, 3 – sufficient information, 4 – detailed information, 5 – very detailed information.

The usefulness of the first 10 links about each system was estimated. In this order for each type of page and for each kind of information the usefulness $A_{Pi}$ was estimated with the aid of above-mentioned six-point scale and then the mean value $A_P$ and the mean value $A_I$ was calculated for each type of page and each kind of information, respectively. It means that if in the case of any system the given type of page does not have any links, the assessment $A_P$ is zero.

**Table 4. Assessment of the usefulness of information of the first 10 links about GPS system**

| Type of page | Type of information | | | | | Mean value $A_P$ |
| | topicality | access | reliability | principle of work | historical review | |
|---|---|---|---|---|---|---|
| encyclopedic | 5 | 5 | 4 | 5 | 5 | 4.8 |
| producers | 3 | 1 | 3 | 3 | 2 | 2.4 |
| governmental | 5 | 4 | 5 | 5 | 2 | 4.2 |
| institutional | 2 | 3 | 5 | 5 | 1 | 3.2 |
| private | 0 | 0 | 0 | 0 | 0 | 0 |
| web portal | 4 | 4 | 3 | 3 | 3 | 3.4 |
| Mean value $A_I$ | 3.2 | 2.8 | 3.3 | 3.5 | 2.2 | $A_S = 3.0$ |

The final assessment for each system $A_S$ is the mean value of usefulness of all six types of page $A_P$. The assessment of the usefulness of the most frequently used NSS, i.e. GPS system, is shown in Table 4. We can recapitulate that:

- the greatest mean value of $A_P$ is for the encyclopedic pages (4.8) and the governmental pages (4.2), the lowest is for the producers' pages (2.4) and private pages (0 – no page of this type);
- three types of page provide very detailed information ($A_{Pi} = 5$) − encyclopedic, governmental and institutional, while very limited information ($A_{Pi} = 1$) is provided by two pages – producers and institutional;
- the greatest and the lowest mean value of assessment in the case of information $A_I$ contained in all types of pages are principle of work (3.5) and historical review (2.2), respectively;
- in the case of information, the best assessment is for all five types, while very limited information (1) is for two kinds – access and historical review;
- the final assessment of information ($A_S$) about the GPS system is 3.0, this value is small because the value of $A_P$ in the case of one page (private) is zero.

The assessment of the usefulness of all 12 systems $A_S$ is presented in Table 5. We can say:

- the best assessment of the system, i.e. the greatest values of $A_S$, is for the SBAS system (3.6), Galileo system (3.3) and WAAS system (3.1), the worst assessment, i.e. the lowest values of $A_S$, is for MSAS system (1.9) and SDCM system (2.0); mean value $A$ of all 12 $A_S$ is equal to 2.8; i.e. the final assessment of 12 systems is near sufficient;

**Table 5. Assessment of the usefulness of the first 10 links about the system (25.04.2015)**

| Keyword | Assessment $A_P$ of the different kinds of the pages | | | | | | Mean value $A_S$ |
| | encyclopedic | producers | governmental | institutional | private | veb portal | |
|---|---|---|---|---|---|---|---|
| GPS system | 4.8 | 2.4 | 4.2 | 3.2 | 0 | 3.4 | 3.0 |
| system GLONASS | 4.8 | 0 | 4.8 | 2.8 | 2.4 | 3.4 | 3.0 |
| Galileo system | 4.8 | 0 | 4.2 | 4.2 | 3.4 | 3.0 | 3.3 |
| BeiDou system | 4.4 | 2.0 | 4.4 | 0 | 1.6 | 3.6 | 2.7 |
| IRNSS | 3.8 | 0 | 2.8 | 4.2 | 2.8 | 2.8 | 2.7 |
| SBAS system | 2.8 | 4.6 | 2.8 | 3.0 | 3.4 | 4.8 | 3.6 |
| EGNOS system | 3.2 | 0 | 3.4 | 5.0 | 0 | 4.6 | 2.7 |
| WAAS system | 4.6 | 2.8 | 5.0 | 3.6 | 0 | 2.6 | 3.1 |
| MSAS system | 2,0 | 2.6 | 0 | 3.2 | 1.4 | 2.0 | 1.9 |
| SDCM system | 2.2 | 0 | 4.2 | 3.6 | 0 | 1.8 | 2.0 |
| GAGAN System | 4.0 | 0 | 3.6 | 3.0 | 3.2 | 2.6 | 2.7 |
| QZSS | 4.2 | 0 | 3.6 | 4.4 | 0 | 2.6 | 2.5 |
| Mean value $A_P$ | 3.8 | 1.2 | 3.6 | 3.4 | 1.5 | 3.1 | $A = 2.8$ |

- SBAS receives the best assessment because it is the only system for which all six types of page have links, all other 11 systems have at least one type of page without links, e.g. seven systems do not have links on producers' pages;
- the types of pages for which the values of $A_P$ are the greatest (the best assessment) are encyclopedic (3.8), governmental (3.4), institutional (3.4) and web portal (3.1), while the lowest are producers (1.2) and private (1.5);
- two types of pages, encyclopedic and web portal, have links in the case of all 12 systems, all the other 4 types have one system at least without links.

## Conclusions

- The number of links consisting of the information about given satellite navigation system depends on the search engine and keyword, for some global systems it is several hundred million;
- for all SNSs and SBASs the number of links for the keyword consisting of the one word only – just the name of the system – is greater for the search engine Google than for the search engine Bing, sometimes considerably;
- for three global NSSs, GPS, GLONASS and Galileo, the number of links for all three keywords for both search engines is considerably greater than for the BeiDou system;
- in the case of SDCM and GAGAN the number of links for the keyword consisting of just the system's own name is a few times greater than for the keyword consisting of the additional word "system" because the names of these systems. (i.e. acronym or word formed from the initial letters of the other words) relate directly to different associations and organizations in Poland and all over the world;

- for all 12 systems taken into account, the biggest number of links consisting of information about the system only is for the two word keyword (i.e. the own name of the system and the word "system");
- the types of pages with information about the system are diverse, however the most frequently used and at the same time the most useful, are the web portal pages and the pages of different interested institutions.

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