Digital Object Identifier (DOI) – an Important Element in Scientific Communication

Elena Pavlovska

Index Information Center, Hristo Belchev Str., 2, 1000 Sofia, Bulgaria
e.pavlovska@index2000.bg

Abstract. Digital object identifier (DOI), which appeared in the late 1990s, allows users to immediately find on the Internet the digital object they are interested in – an article, book, journal, dissertation, etc. Nowadays the DOI technology is widely used by foreign publishers. The availability of DOI in scientific documents, as well as the inclusion of DOI in bibliographic references in the literature, has already become a mandatory requirement for journals indexed in the Web of Science and Scopus databases. Unfortunately, DOI is included only by some journals published in Bulgaria. The article presents some new opportunities which DOI opens not only to scientific journals, but also to authors.

Keywords: Digital Object Identifier (DOI), Scientific Communication, CrossRef, Scientific Journal, Article, ResearcherID , ORCID.

1 Introduction

Scientific communication is the process of promotion and dissemination of scientific knowledge about the surrounding reality through different channels, means, forms and institutions of communication. At the turn of the XIX—XX centuries, thanks to the development of information technologies and the Internet, new forms of interaction have emerged between the subjects of scientific communication: virtual scientific conferences, scientific open access journals, scientific electronic archives. The transition to information society underlined the particular importance of information provision of the society. The interest of the public to scientific achievements and science, in general, has increased. Society moves to the ideal of accessible, open science, in which the results of scientific research are accessible to all.

Those belonging to the scientific community exchange opinions at scientific forums, discuss research results, and their scientific ideas are formalized as scientific literature in accordance with scientific criteria. After approval of scientific ideas in the scientific community, scientific communication goes to a new stage – the stage of popularization, which occurs through popular science magazines, science blogs, scientific electronic libraries, educational broadcasts, and exhibitions (Investigating, 2009; Communicating, 2010). In the last decades of the Twentieth century, the mass media have become an instrument of popularization of scientific communication (Habermas, 1971).

Digital Presentation and Preservation of Cultural and Scientific Heritage. Conference Proceedings. Vol. 7, Sofia, Bulgaria: Institute of Mathematics and Informatics – BAS, 2017. ISSN: 1314-4006, eISSN: 2535-0366

One of the means of scientific communication within the scientific community is the system of indexes of scientific references in all fields of modern science, created under the leadership of E. Garfield in the early 1960-s. International scientometric databases or "global citation indexes" such as Web of Science (which are the development of Garfield's ideas) and SCOPUS, play an important role in the modern scientific world, as they are the main sources of information about the most significant achievements of world science and technology. The structure of citation indexes allows them to perform a rather wide range of functions, the main of which are the following:

- search for information by individual researchers and scientific organizations;
- use of links between publications to reveal the structure of knowledge areas, to observe and predict their development (mapping of science and identification of new scientific trends);
- identification of scientometric indexes of publications and evaluation of their authors by the scientific community.

An important element of the modern system of scientific communication is DOI, the importance of which is the subject of the present article.

2 What is DOI?

The Internet is constantly developing, increasing in size, and changing. Most of the electronic content does not need long-term storage, but it is desirable to keep scientific literature stored constantly. In the course of time websites change, some of them disappear, and as a result it becomes impossible to find a particular book or article. All of us, who are using the Internet and going through the links, have seen message such as "Error 404" or "Page not found", which informs us that a particular article is not linked to this page, any more. In the middle of the 1990s, it was suggested that DOI could be used as a permanent reference that would lead the user to the desired document, even if the website, and consequently, the URL of the document, had changed.

DOI (digital object identifier) – an identifier of a digital object –is the standard for designation of the presented in the Internet information about the electronic document (International, n.d.). In fact, DOI is the path to permanent location of the document on the Internet for obtaining the necessary information about it (Paskin, 1999).

The DOI system of identification is used in different information segments (scientific information, normative documentation, training materials, reporting documentation, etc.). The registration agency CrossRef is responsible for the segment of scientific literature (CrossRef, n.d.).

The data contained in the DOI of an electronic document includes indicator of its location (e.g., URL), its name (title), other identifications of the object, such as ISBN for electronic version of a book, ISSN for electronic version of a journal and associated with the object set of describing it data (metadata) in a structured form (Paskin, 2010).

DOI can be assigned to any object:

- a journal, separate issue or volume of the journal;

- an article or a part of the publication;
- a book, book series, a book chapter;
- conference proceedings (collections of reports);
- a dissertation;
- a preprint, etc.

The main functions of DOI with regard to scientific publications are:

- constant reference to a digital object, regardless of its location in the network;
- ability for citing of preprints of articles;
- ability for searching a publication by DOI in bibliographic databases.

The availability of DOI in scientific documents, as well as the inclusion of the identifier in the bibliographic data in reference lists in the literature, already has become almost a mandatory requirement for journals indexed in Web of Science и Scopus databases. It is not coincidental that the site of one of the world's largest scientific resources, www.sciencedirect.com, recommends the use of DOI for links to its contents.

This identifier is present in most publications of international periodicals but is rarely found in the Bulgarian journal segment, which significantly reduces the international visibility of Bulgarian publications. This is partly due to the commercial character of the DOI for publishers, which have to pay the registering organizations for the assignment of identifiers and for subsequent annual maintenance.

Nowadays DOI technology is firmly used by foreign scientific publishers:

- more than 5 thousand organizations assign DOI to their materials;
- 18 thousand DOI prefixes have been registered;
- digital identifiers have already been assigned to more than 130 million objects (Skalaban, n.d.).

3 Structure of the DOI

The digital object identifier (DOI) is a unique identification number of the article, which presents a string of letters and numbers consisting of two parts: a *prefix* and a *suffix*.

The DOI format usually looks like this: XX.YYYY/ZZZZZZZZZZ, where XX and YYYY is a prefix (numbers identifying the publisher). The prefix is assigned by the registration agency CrossRef. The prefix cannot change.

Symbols ZZZZZZZZZZ are a suffix (a string of letters and numbers encoding a journal and a particular article); it is formed by the publisher according to the established by him rules. The suffix must be unique for this publisher. Both the suffix and the prefix are inseparable parts of the DOI; they form a single whole. Fig 1. shows a typical DOI structure.

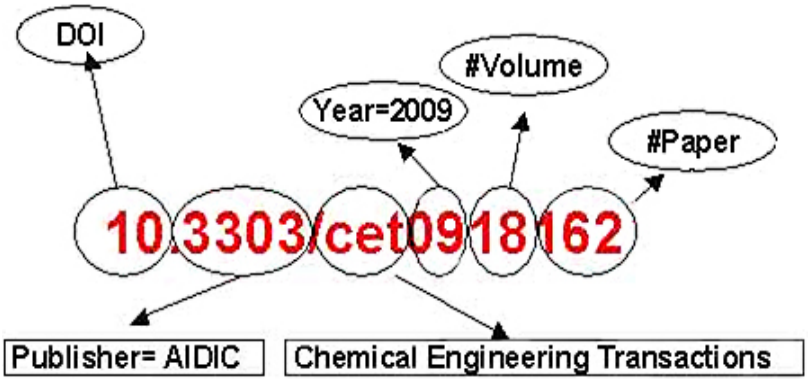

Fig. 1. The DOI structure

But this is only one of the possible schemes. One can choose any other — for example, using the ISSN of a journal. In this case, DOI will contain: the ISSN of the journal, publication year of the journal, volume, issue (serial number of the journal in the current year), the first page of the described article in the given issue, the last page of the article in this issue.

Digital object identifier does not depend on the keyboard register. For example, the identifiers 10.1006/abc and 10.1006/ABC refer to the same digital object.

For each publication that has DOI, the identifier must be written in small printing type on the first page. Besides, it is also indicated in the journal's website on the page with this publication. Usually DOI is specified before or after the abstract to the article (e.g. http://dx.doi.org/10.1016/j.matcom.2008.08.004), but it can also be placed at the bottom of the web-page (for example, http://dx.doi.org/10.1007/s10067-010-1380-z).

To find the article on the Internet, it is enough to type the following symbols: http://dx.doi.org/DOI of the searched article in the browser.

4 How Can DOI Benefit Journals?

- Any journal having a DOI is automatically registered by quite a lot of repositories and libraries.
- Even if the website (URL) changes, the user can always find the needed article from the journal.
- CrossRef has a free service called Cited by Linking (Crossref., n.d.) for cooperating publishers which shows by whom and when a particular article was cited. This service is performed through DOI, since, in accordance with the terms of the contract, the publisher, besides the mandatory registration of DOI of articles of the last three years, for 18 months has to place on his website the lists of literature of these articles with outgoing links to original publications. In this way, if the article from the journal was cited in some other publication having DOI, there is a high probability that the user from the website of the citing journal will go to our website, and this helps attract new readers, authors and reviewers. To participate in Cited by Linking, the

publisher has to submit these lists of literature (published on its website) to CrossRef, and it is necessary to provide for a possibility of placing on the website both lists of literature and information by whom this article was cited. This undoubtedly leads to increasing the "visibility" of the journal, the number of readers and authors, and, potentially, to increasing citations and the journal's rating (Tihonkova, n.d.).

- There is a list of additional benefits for using DOI: finding plagiarism, notification on additions/updates to the article, information about financial support for the project, etc.

In order to have a possibility to assign DOI to articles and scientific journals issues, it is necessary to sign a contract with one of the official DOI registrars or contact third parties already having a valid contract. In order to get the publishing prefix, the best approach would be to sign a contract with the largest DOI registrar, CrossRef.

All prices and services of CrossRef are shown on the official website of the organization. First of all, it is necessary to pay annual membership fees (CrossCheck Annual Fees), amounting to $275. Annual fees are paid not by a separate journal, but by publishers or scientific and educational institutions.

5 Why Scientists Need DOI?

In the English-speaking scientific environment, DOI is used not only by publishers and editorial boards of scientific journals; this identifier is adopted for exchange of data between scientists. Unfortunately, this opportunity is very rarely used in our country.

Ministry of Education and Science of the Republic of Bulgaria has prepared a new project on amendments of the Law on the Development of Academic Staff, within the framework of which, in the spring of 2017, a Minimum list of criteria for obtaining scientific degrees and scientific positions in scientific research institutes and higher educational institutions was developed. The requirements represent a set of generalized indicators in the relevant scientific field. Most of the indicators are scientometric, reflecting the scientist's achievements in the relevant scientific field: number of author's monographs, articles in journals indexed in international scientometric databases (Web of Science Core Collection and Scopus), number of citations of the author, etc.

The usual way for inclusion of a scientific work in the Web Science and Scopus is to publish research results in the journals included in these databases. These are mostly foreign scientific journals (Kirilova, n.d.). Bulgarian journals are scarcely presented in Web of Science and Scopus, and mainly in the field of natural sciences. For a Bulgarian scientist, it is very difficult to get a paper accepted in a refereed foreign journal, and this is practically impossible for papers in the economic, humanitarian and social sciences. But if the Bulgarian author's work has a DOI, and if it was cited by a scientist (for example, by a foreign colleague) in a publication in the journal included in the Web of Science and Scopus, this work is automatically included in Web of Science and Scopus and gets its own citation index.

In addition, when DOI is assigned to a publication, an annotation is created, and keywords from it in English are sent to the public database www.doi.org; then they are indexed by search engines, and as a result, the work becomes available for searching

by keywords to scientists in the whole world, which also increases the chances for citing the work. The increase in the number of citations of the author's articles automatically increases his citation index and h-Index – the most important author's scientometric indicators.

6 Value of Digital Object Identifiers

The main objective (idea) of open science is create an orderly networked scientific information space. As the authors (Gureev, n.d.) of the article note, at present there is no single accepted global method for identification of journal articles, authors and other elements of bibliographic metadata. This problem is particularly important when using the same information in different scientometric and bibliographic databases to perform complex processing of the data with further integration of the obtained data. That is why, in spite of the fact that in recent years a number of different identifiers have been introduced (in the field of scientific communication – such digital author's identifiers as Researcher ID (ResearcherID, n.d.), ORCID (ORCID, n.d.), the only binding link is the DOI identifier.

7 Conclusion

The DOI identifier has a lot of functions due its universal character, which allows its integration not only in the processes related to publishing, but also in all world scientific communication. But the most important function of DOI is to directly connect scientists, researchers and authors through their scientific works.

The use of DOI increases the "visibility" of the article, the reputation of the journal, taking into account citation of articles, allowing integration in international databases (Scopus, Web of Science, EBSCO, DOAJ, etc.). It also connects such areas as altmetrics, identifiers of authors ORCID and ResearcherID, as well as systems of data storage on research and management (Mendeley, Zotero) and systems for search of plagiarism. Finally, as this standard has been accepted by all leading publishers in the world, it is possible to consider materials carrying DOI as belonging to the world scientific literature.

References

(n.d.). *CrossRef web site.* Retrieved July 2017, from http://www.crossref.org

(n.d.). *Crossref. Cited-by linking.* Retrieved June 2017, from http://serials.lt/wp-content/uploads/2015/06/2015-6-cited-by-Lithuania.pdf

Gureev, V. N. (n.d.). *Identification in information bibliographic systems: Problems and solutions.* Retrieved July 2017, from http://gpntb.ru/win/inter-events/crimea2014/disk/066.pdf

Habermas, J. (1971). The scientization of politics and public opinion. In H. J., *Toward a Rational Society – Student Protest, Science and Politics* (pp. 62-80). London: Heinemann.

Holliman, R., & etc. (Eds.). (2009). Investigating science communication in information age. Implications for public engagement and popular media. Oxford: Oxford Univ. Press.

(n.d.). *International DOI Foundation [website]*. Retrieved July 2017, from http://www.doi.org

Kahlor, L., & Stout, P. (Eds.). (2010). *Communicating science: new agendas in communication.* N.Y.

Kirilova, O., & Parfenova, S. (2017). *Metodicheskie rekomendazii po podgotovke i oformleniju nauchnih statej v zurnalah, indeksiruemih v mezdunarodnih naukometricheskih bazah dannih.* Moskva: Nauka.

(n.d.). *ORCID.* Retrieved July 2017, from http://www.orcid.com

Paskin, N. (1999, May). DOI: Current Status and Outlook. *D-Lib Magazine, V*(5). Retrieved July 2017, from http://www.dlib.org/dlib/may99/05paskin.html

Paskin, N. (2010). Digital Object Identifier (DOI) System. In *Encyclopedia of Library and Information Sciences* (Third ed., pp. 1586-1592). Taylor & Francis. doi:10.1081/E-ELIS3-120044418

(n.d.). *ResearcherID.* Retrieved July 2017, from http://www.researcherid.com

Skalaban, A., Mitrofanov, M., & Dimentov, A. (n.d.). *Ispolzovanie tzifrovogo identifikatora DOI v sovremennoj nauchnoj kommunikazii.* Retrieved July 2017, from https://www.slideshare.net/aleshka17/doi-66392733

Tihonkova, I. (n.d.). *DOI (digital object identifier) dlja nauchnih jurnalov. Prakticheskie soveti nebolshim izdatelstvam.* Retrieved July 2017, from http://www.nas.gov.ua/publications/books

Received: July 13, 2017
Reviewed: July 30, 2017
Final Accepted: August 10, 2017