

Item in dependability: definition and content of the concept

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Abstract. Aim. The paper continues the series of publications that investigate and discuss the essence and definitions of the basic concepts of the dependability theory. It analyzes the basic concept, which is the subject of consideration in dependability, for which the term “item” is usually used. The concept of “dependability” is defined for it, and in general all the terminology of dependability applies to it. The following issues are considered: how to name and define this subject of consideration, what it can be, what can be its constituents. In particular, the relationship between the concepts of “item” and “product” is discussed. **Methods.** The evolution of definitions of this concept in the Russian and international terminological standards in dependability over the past 30 years is traced. A comparative analysis of other standards and federal laws relating to items of different types is carried out. The viability of two main ways of getting an idea of a concept is considered: illustrative (based on examples) and definitional (by means of sequential definition of some concepts through others). **Findings and conclusions.** The definition and correct understanding of the concept of “item” is of great importance, as it affects the scope of dependability standards. It is explained why it is necessary to accept that the definitions of the basic concepts cannot be rigorously formalized and are in fact only explanations. It is shown that the definitions of the item in the existing Russian and international standards (GOST 27.002–2015 and IEC 60050-192:2015) have inaccuracies. To eliminate them, improved notes to the definition of an item are proposed. The first note lists the possible types of items: products (parts, assembly units, complexes) and their components; buildings and structures; systems consisting of jointly functioning products and structures and their subsystems. The second note indicates the relationship between the main constituents of the item: hardware, software and people (personnel), and their possible combinations. The paper provides reasons for considering virtual items that play an important role in today’s information and telecommunication technologies and are logically isolated subsystems within the systems that they are part of. Besides that, it points out the deficiencies in the definitions of various items in GOST 18322–2016.

Keywords: dependability, standardization, item, definition, types of items, constituents of an item.

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Introduction

The dependability theory has existed for several dozen years, however its basic definition are still debatable. Over the last few years, they were examined in a number of papers motivated by the development of the Russian and international dependability terminology standards (GOST 27.002–2015 and IEC 60050-192:2015) and the subsequent analysis of such standards [1–6, etc.]. For instance, an animated discussion of how to define the very concept of “dependability” took place in [2]. In the author’s opinion, all of that indicates that the dependability theory is alive and well, rather than in the middle of a crisis.

This paper analyzes the concept that precedes the concept of “dependability”. More specifically, it discusses the subject matter of dependability, i.e. the dependability of what should be studied. This concept is normally expressed with the term “item”. It is defined in a number of standards. However, there is no perfect clarity in this aspect either and discussions also took place. The following issues will be considered: how to name and define this subject of consideration, what it can be, what its constituents can be. Simultaneously, the observations expressed in [4, 5] regarding GOST 27.002–2015 *Dependability in technics. Terms and definitions*, that are associated with the topics of this paper, are analyzed as well.

Background

Up until 2009, the main text of Russian dependability terminology standards lacked a term that would correspond to the subject matter of dependability. The basic definitions use the term “item”, while in the informative annex, that contains terminology notes, it is explained that the terminology of dependability in engineering covers all technical items, i.e. products, structures and systems, as well as their subsystems considered in terms of dependability at the stages of design, manufacture, testing, operation and maintenance. Further, it was indicated that subsystems may include assembly units, parts, components and elements (wordings per GOST 27.002–89).

In 2009, instead of GOST 27.002–89, GOST R 53480–2009 was adopted that was later designated GOST R 27.002–2009. It was developed taking into account the primary regulations of international standard IEC 60050-191:1990 *International electrotechnical vocabulary – Part 191: Dependability and quality of service*. Let us note that the International Electrotechnical Commission is instrumental in the international standardization of dependability [7].

GOST R 27.002–2009 uses the term “product” that is defined as any functional unit that can be considered individually. Note 1 thereto mentions examples of such entities: system, subsystem, equipment, device, apparatus, module, component, element. All primary concepts of dependability in that standard were defined in the context of product.

The official Russian translation of IEC 60050-191:1990 gave the single Russian equivalent “*ob’ekt*” (item, literally “object”) for the two English terms “item” and “entity”,

which were treated then as synonyms. An item (entity) was defined as any part, component, device, subsystem, functional unit, equipment or system that can be individually considered. Thus, a part of that wording was used in GOST 27.002–2009 as the definition, while another part was featured in the note thereto.

GOST 27.002–2009 was heavily criticized by experts, as the result of which the validity of GOST 27.002–89 was resumed (that matter was described in detail in [2]). One of the novelties that were criticized was the replacement of the term “item” with the term “product”. There is more to that than the deviation from the terminology everyone got used to over the years. A stronger point consisted in the fact that the term “product” had already been standardized as part of the Russian Unified System for Design Documentation (USDD). The then-active GOST 2.101–68 *Unified system for design documentation. Types of products* stated that a product is any article or set of articles, that are to be manufactured at an enterprise. Thus, an undesirable discrepancy arose between the definitions of the same term in baseline technical standards. At the same time, the understanding of the term “product” in USDD that assumes the manufacture at an enterprise is narrower than the concept of “item” in dependability. The latter, for instance, includes communication lines, networks and channels, power transmission lines, pipelines etc. All of them are not products according to USDD.

In 2015, IEC 60050-191:1990 was replaced by IEC 60050-192:2015 *International electrotechnical vocabulary – Part 192: Dependability*. A general analysis of that standard was done in [3]. Out of the above-mentioned English terms it retained only the first one (item) that was defined simply as a subject being considered. Note 5 thereto explains the reasons for the modification: “The definition of item in IEC 60050-191:1990 is a description rather than a definition. The new definition provides meaningful substitution throughout this document. The words of the former definition form new note 1”.

The same year, GOST 27.002–2015 was adopted. Its development aimed, on the one hand, to maintain the continuity with GOST 27.002–89, and, on the other hand, to approximate the new international standard. As the result, the following definition was adopted: item is the subject of consideration covered by the terminology of dependability in engineering. Note 1 thereto cites a list of possible items: assembly unit, part, component, element, device, functional unit, equipment, product, system, structure.

Subsequent publications made remarks regarding this definition, however, they will be considered later. First, a general theoretical observation should be made regarding the definition of basic concepts.

The problem of basic concepts definition

The difficulties associated with the definition of basic concepts are common not only to the dependability theory; they are general in their nature. The well-known mathemati-

cian and linguist V.A. Uspensky wrote the following: “... How can one get an idea of a certain concept? There are two primary ways, one of which we will conventionally call *illustrative*, while the other we will equally conventionally call *definitional* (from lat. definitio, meaning definition). Under the illustrative method, a concept is acquired using examples, under the definitional method, it is acquired using definitions. <...> ...Under the definitional method, some concepts are defined through others, others through still others, etc. But this process cannot continue indefinitely. That means that we must stop at certain ... concepts and not define them any further. Such concepts, that do not have definitions, are called *indefinable*, or *original*. But if original concepts cannot be defined, ...how can we know, what they mean?” [8, p. 309–310, 312–313].

In mathematics, the axiomatic method provides a way out [8, p. 313]. In other fields of knowledge, that are not as strictly formalized, we have to put up with a situation, when the definitions of original concepts are mere explanations, much like the Euclid’s definitions of the basic concepts of geometry (“a point is that which has no part”, “a line as breadthless length”, etc.) [8, p. 307]. Therefore, the fact that GOST 27.002–89 and preceding standards did not define, but rather just explained an item, makes some sense.

Indeed, strictly speaking, the definitions of item in IEC 60050-192:2015 and GOST 27.002–2015, are not really definitions. That explains the importance of the examples of items given in the notes to the definitions in such standards, because, as previously mentioned, under the illustrative method, a concept is acquired with the use of examples specifically.

Sometimes, attempts of finding a way out of the above difficulty cause a vicious circle in the definitions, whereas a concept is defined through itself or concept A is defined through B, while B is defined through A. An example of such situation in standards will be provided below. Naturally, that represents a serious shortcoming in such standards.

Types of items

In [4] it is justly noted, that the list of the types of items given in note 1 to the definition of item in GOST 27.002–2015 is not coordinated with GOST 2.101–2016 *Unified system for design documentation. Types of products*. Indeed, according to GOST 2.101–2016, a product is an article or set of articles, that are to be manufactured by an organization (enterprise) in accordance with design documentation. Moreover, in note 1 to that definition it is stated, that products may include devices, facilities, machines, units, instruments, appliances, equipment, installations, tools, mechanisms, systems, etc. GOST 2.101–2016 also defines a product component as a product that performs certain functions as part of another product, and specified the types of products in terms of structural and functional characteristics: part, assembly unit, complex and set (kit).

If the first three types of products (part, assembly unit, complex) are certainly items in terms of dependability, a set

should not be considered as such. Indeed, a set is two and more products, that were not put together at the manufacturing enterprise by means of assembly operations, and are a number of products that share the same operational purpose that is auxiliary in its nature, e.g.: a set of spare parts, a set of tools and accessories, a set of instruments, a set of package, etc. (definition according to GOST 2.101–2016). Therefore, for a set there are no common required functions, whose maintained performance characterizes dependability. Certainly, that does not rule out the possibility of individual consideration of the dependability of the products in a set.

While examining the concept of “product” let us simultaneously note that in GOST 2.101–2016 its definition is complemented with a reference to design documentation that was absent in the previous version of the standard published in 1968. At the same time, GOST 2.001–2013 *Unified system for design documentation. General principles* defines design documentation as a set of design documents, that contain data required for the design (development), manufacture, supervision, acceptance, delivery, operation, repair, upgrade, disposal of a product. Thus, there is a vicious circle: the definition of “product” refers to “design documentation”, while the definition of “design documentation” refers to “product”.

In GOST 27.002–2015, it is stated, that the requirements for an item are specified in the documentation for such item. In [5], that is cited among the shortcomings of that standard (“fuzziness of dependability terminology”). It is also proposed to refer to design documentation specifically. However, such documentation is associated only with products, i.e. by far not all types of items. Besides, in GOST 27.002–89 the wording also was not limited to design documentation only. It referred to regulatory and technical and/or design (project) documentation.

Another observation in [4] is about the harmonization of GOST 27.002–2015 and GOST 18322–2016 *Maintenance and repair system of engineering. Terms and definitions*. Each of those standards states that they are applied jointly with the other. Unfortunately, there are indeed some discrepancies between them, which include the interpretation of “item”. Although, reading [4] one can think that in GOST 18322–2016 there also is a definition of “item”, while in reality that is not so. This standard defines the terms “maintenance (repair) item”, “maintainable item”, “non-maintainable item”, “repairable item”, “non-repairable item”. The wording cited in [4] “an item is a whole that consists of interconnected parts integrated within it for the purpose of performing a common target function” is just a note to the specified terms. However, the definitions of all the above terms in GOST 18322–2016 contain the word item (in Russian “*ob’ekt*” – “object”). We can only guess what exactly that means. Probably, that is the item defined in GOST 27.002–2015. In any case, an explanation was supposed to be provided.

Then, the terms “maintainable item”, “non-maintainable item”, “repairable item”, “non-repairable item” are present in both standards. At the same time, the definitions of the

first two of them in GOST 18322–2016 match the definition of such terms in GOST 27.002–2015 (though with no reference thereto), while those of the last two are slightly different from those given in GOST 27.002–2015. Indeed, one would want following the authors of [4] and exclaim: “What to believe?” Upon a careful examination of the above terms, further questions arise. What is the difference between a maintenance item and a maintainable item, and between a repair item and a repairable item?

The next observation in [4] is about the harmonization of GOST 27.002–2015 with the Federal Law of December 30, 2009 no. 384-FZ *Technical Regulations on the Safety of Buildings and Structures*. It is perfectly justified. Along with structures, the list of types of items should include buildings (though it is still unclear why in [4] they are referred to as components of items, as they are an individual type of item). The feasibility of such addition is further supported by GOST 27751–2014 *Reliability for constructions and foundations. General principles* and GOST R 58033–2017 *Buildings and civil engineering works. Vocabulary. Part 1. General terms* (the latter mentions dependability).

The list of items also includes systems consisting of products and structures, that jointly perform certain functions (for instance, communications networks, electric power systems, gas distribution networks, etc.) and their subsystems. In particular, dependability of electric power systems is extensively covered in the Federal Law of March 26, 2003 no. 35-FZ *On the electric power industry*.

Virtualization is an important trend in today’s information and communication technologies. Information systems can use virtual computers, virtual data storage systems, etc. (the definitions of those and other similar concepts are given in GOST R 56938–2016 *Information protection. Information security with virtualization technology. General*). In telecommunications, virtual networks, virtual channels and paths are used (for instance, virtual private networks are considered in GOST R 53729–2009 *Quality of service “allocation of the Virtual Private Network”*. *Quality indices*). Network virtualization is considered as one of the key technologies of future networks [9]. While examining their dependability, we should allow for the existence of not only physical, but virtual items as well. Normally, they are logically distinct subsystems within systems that serve as foundations for virtual items.

Given the above, the following wording of note 1 to the term “item” is proposed: items may include products (parts, assembly units, complexes) and their components, buildings and structures, systems consisting of jointly functioning products and structures, and their subsystems.

What an item includes

Now, let us consider the question as to what can be included in an item. The above mentioned notes to GOST 27.002–89 stated that, if required, the concept of “item” can include information and its media, as well as the human factor (for instance, when considering the depend-

ability of operator-machine systems). This wording does not appear to be very good, especially the last part: how can a factor be included into an item?

In IEC 60050-191:1990, note 1 to the term “item” states that an item may consist of hardware, software or their combinations and in particular cases may include people. A similar wording makes note 2 to the term “entity” in GOST R 27.002–2009. Let us note that in the official Russian translation of IEC 60050-191:1990 the word “people” was replaced with “technical personnel” (by the way, the French version of the standard uses the term “personnel”).

In the current standards IEC 60050-192:2015, in note 2 to the term “item” it is stated, that an item may consist of hardware, software, people or any combinations thereof (the French version, again, uses the word “personnel”). Accordingly, in GOST 27.002–2015, note 2 to the term “item” states that an item may include hardware, software, personnel or their combinations. This wording (in particular, the reference to personnel) was criticized in [4].

Let us analyze, whether software and people (personnel) should be included in an item along with hardware.

It is well known that software must be taken into consideration while examining the dependability of program-controlled items. The interrelation between the hardware and software components of such items was clearly and convincingly shown in [10]: “...As a separate entity, computer software only exists up until the moment it is entered into the memory device (MD) of a machine. Up until that moment the software exists not as a technical item (and not even as a component of a technical item), but as a document... Naturally, during that period of its existence (to the moment of entering into a computer’s MD) a piece of software cannot operate on its own... Subsequently, during that period the program does not have any operating properties of a technical item, including dependability... <...> After the program’s entering into a computer’s memory, it stops being a separate entity and can be considered only as information on the state of a certain set of physical memory units... Now, it is impossible to pinpoint the boundary between the computer’s hardware and its software, that has been entered and according to which the machine can only operate... <...> ...Computer hardware alone with no software installed in the MD is also incapable of processing information (it can only get hot, when the power is on, but that is not the “required function” of a computer), and subsequently, the dependability of those hardware elements alone cannot fully characterize the dependability of an entire computer”.

As to people, it has also long been known that human operators must be taken into consideration in the context of dependability of human-machine (or operator-machine as in GOST 27.002–89) systems. That, for instance, is reflected in GOST 26387–84 *Man-machine system. Terms and definitions*. Thus, GOST 27.002–2015 does not introduce anything radically new in this regard.

However, we should admit that the wording from IEC 60050-192:2015 allowing for any combination of hardware, software and people, that was, though in a less

strict form, in GOST 27.002–2015, is an error. For instance, a combination of only software and people without hardware appears to be meaningless.

Given the above, we propose the following improved wording of note 2 to the term “item”: along with hardware components, an item may include software required for its operation, and operational personnel in the case of human-machine systems.

Conclusion

The definition of the concept of “item” that is the subject matter referred to by the terms and definitions of dependability in engineering is of great significance, as it affects the application field of dependability standards. For the purpose of its specification, the following refined notes are proposed to its definition in GOST 27.002–2015. Note 1: items may include products (parts, assembly units, complexes) and their components, buildings and structures, systems consisting of jointly functioning products and structures, and their subsystems. Note 2: along with hardware components, an item may include software required for its operation, and operational personnel in the case of human-machine systems.

The current situation in the standardization of scientific and technical terminology in general, and in the area of dependability in particular, leaves much to be desired, which was shown in [4, 6]. Some proposals aiming to improve the situation were expressed in [6].

The author calls upon all the interested experts to share their opinion and put forward proposals both regarding the essence of the matters at hand and the proposed corrections, as well as in terms of organizational measures aimed at improving the situation.

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The author's contribution

The author analyzed the definitions of the concept of “item” in the Russian and international standards, identified their shortcomings and proposed improved wordings of notes to the definitions of item as regards the possible types and primary components thereof.