Use of the terms “estimate” and “definition” in dependability-related standards

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Abstract. *The paper aims to improve the terminology used in dependability-related state standards. Examples are given of the use of the terms “estimate” and “definition” in the “Risk management” and “Dependability in technics” series of state standards. The meanings of those terms were clarified based on the existing regulatory documents. Requirements for the integrity of the used terms were defined. Wordings were proposed for the term definitions that feature the words “estimate” and “definition”.* **Aim.** *To examine and discuss the common, but not sufficiently substantiated terms “estimate” and “definition” used in state standards, i.e., to consider the legitimacy of their application as part of the above series of state standards. Proposals as to the improvement of such terms’ application were also set forth.* **Methods.** *Examples are given of the use of the terms “estimate” and “definition” in state standards. Based on the existing state standards, the actual meanings of the considered terms were clarified: “definition” refers to the way a term is defined, while “estimate” and “estimation” are closely associated with mathematical statistics. The requirements for the integrity of the used terminology are defined and come down to it being unambiguous, consistent within itself and across the relevant state standards. In this context, the shortcomings of the examined terms are shown that are associated with the above requirements, i.e., the meaning, content, essence and key features of such terms are clearly defined. Any comments or references to other regulatory documents are missing as well.* **Results.** *In most standards, in the “Terms and definitions” section, the concept of “definition” is used correctly, i.e., terms are defined. However, in other cases, the concept of “definition” is used in a different sense, as nothing is actually being defined. Based on the term integrity requirements and in light of the above shortcomings, proposed replacements for the terms in question were defined. In most cases, instead of the terms “estimate” and “definition”, it is proposed to use the terms “calculation” and “computation”, as well as their cognates, “calculate”, “compute”. It should be noted that along the state standards, these terms are used in technical documentation, science papers, monographs and textbooks.* **Conclusions.** *The use of the examined terms in some standards lacks integrity. The requirements of the standardization recommendations are not observed, the terms are not unambiguous and consistent with other standards. Based on these requirements, the paper proposes improved ways of using the terms “estimate” and “definition”. The suggested terms should be considered as a tentative proposal. Final definitions and/or replacements of these terms are to be developed through extensive discussion and compromise.*

Keywords: *dependability, dependability-related terminology.*

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Introduction

This paper examines the terms used in the "Risk management" and "Dependability in technics" series of state standards. The terms "estimate" and "definition" are used in those standards.

This paper aims to examine the applicability of these terms in the context of specific standards.

The author justifies the use of the terms "estimate" and "definition" relying on the existing state standards [2, 3, 12]. Standard [3] has been replaced with standard [2]. However, in the course of the development and application of the standards of the above series up to 2019, standard [3] was in force. Therefore, the paper refers to both standards of the "Statistical methods" series, the more so since they do not significantly differ in terms of the definitions of primary terms.

Source overview

Most state standards have a "Terms and definitions" section. In particular, those sections feature:

– 16 terms in [1] (GOST R 27.302-2009);
– 6 terms in [4] (GOST R 51901.5-2005);
– 8 terms in [5] (GOST R 51901.12-2007);
– 15 terms in [9] (GOST R IEC 61165-2019).

If the section is blank, a reference to another state standard is provided.

The term "estimate" is commonly used in state standards. Let us note examples of this term's application:

In [1] (GOST R 27.302-2009):
– reliability estimate (6.1.3, 6.13);
– probability estimate (7.5.4.3);
– gate estimate (7.5.2.2);
– fault tree estimate (6.1.2, 7);
– estimating the probability of failure (5.4.3).

In [4] (GOST R 51901.5-2005):
– dependability estimate (A.1.12.1);
– dependability indicators estimate (4.1);
– dependability improvement estimate (4.1);
– estimate of primary event characteristics (4.4.1).

In [5] (GOST R 51901.12-2007):
– estimate of the probability of failure (5.2.9);
– estimate of failure rate (5.3.4);
– calculated or estimated probability of failure (5.3.6.2).

In [7] (GOST R 51901-14-2007):
– estimate of the probability of no-failure (7.2, 8.3);
– probability of no-failure can be estimated using the formula (8.1.1).

In [9] (GOST R IEC 61165-2019):
– estimate of the probability of no-failure (B.1).

Let us note the cases of the application of the term "definition":

In [1] (GOST R 27-302-2009):
– probabilities are defined in the usual way (6.1.3).

In [4] (GOST R 51901-5-2005):
– definition of numerical data (4.1);
– definition of dependability indicators (A.2.4.3).

In [5] (GOST R 51901-12-2007):
– definition of failure mode (5.2.9);
– definition of failure rate (5.3.4).

In [7] (GOST R 51901-14-2007):
– definition of probability of no-failure (6.1).

In [9] (GOST R IEC 61165-2019):
– definition of dependability indicators (9.1);
– definition of probabilities of states (9.1);
– defining system characteristics (8.1).
– definition of expressions for the probability of no-failure and time to failure (C.3.2).

"Estimate" and "definition" are simultaneously used in the following cases:

In [4] (GOST R 51901-5-2005):
– definition of numerical estimates of dependability indicators (4.1);
– definition of numerical estimates of reliability indicators (A.1.12.1);
– definition of estimates (A.1.12.1);
– defining the estimates of dependability indicators (A.1.12.1).

In [7] (GOST R 51901-14-2007):
– definition of numerical estimates of reliability indicators (6.1).

In [9] (GOST R IEC 61165-2019):
– definition of availability estimates (B.1);
– definition of dependability indicators (Section 1);
– definition of probability of failure (7.2).

Let us clarify the meanings of the terms "definition" and "estimate". In the Standardization Recommendations [12], it is stated that definition is a logical technique that allows distinguishing, finding and representing a relevant concept. This logical technique is a wording that clarifies the meaning, content, essence, primary characteristic features of a term using known and meaningful words. According to [12], a definition is the starting point for selecting an appropriate term as standardized.

It should be noted that, according to standard [2], "estimate" is a statistic used for the purpose of estimating a parameter that is a feature of a family of distributions. "Estimation" is a procedure that helps obtaining a statistical representation of a general population from a random sample obtained from such general population.

In standard [3], those terms are defined similarly. An estimate is a statistic used for estimating a parameter, while an estimation is an operation involving the definition of the numerical values of distribution parameters based on sample data. A statistic is defined as a function of sample values. It is a random value that may take different values from sample to sample. A parameter is defined as a value used in the description of the probability distribution of a random value.

Thus, in accordance with standards [2] and [3], the terms "estimate" and "estimation" are directly associated with mathematical statistics.

Table 1. Terms substantiated in [10]

Terms used in standards	**Terms proposed in** [10]
1. “Dependability estimate”	“Dependability calculation”
2. Method of dependability estimation; Method of dependability definition	Method of dependability calculation
3. Computational method of dependability definition	Probabilistic method of dependability calculation
4. Experimental method of dependability definition	Statistical method of dependability calculation

Methods

The Standardization Recommendations [12] state that the terminology is to be unambiguous and self-consistent. The Recommendations set forth the requirements a used term is to comply with. A term must express only one concept and a single concept must be expressed by only one term. Two or more definitions of a single concept are not acceptable. Polysemy (homonymy) and synonymy violate this principle.

It is obvious that the terms, definitions and basic concepts used in standards are to comply with the above requirements. Thus, the integrity of terms, definitions and basic concepts, in the author’s opinion, comes down to the following:

1) all terms, definitions and basic concept set forth in the standard are to be unambiguous and self-consistent;

2) all terms, definitions and basic concepts set forth in the standard are to be consistent with other national standards and not contradict preceding standards.

That means that a national standard **must not contain**:

1) different terms, definitions and basic concepts with identical scope and meaning (must not contain synonyms);

2) one and the same term, definition and basic concept with different scope and meaning (must not contain homonyms);

3) terms previously adopted in other national standards with new, modified scope.

When the above deviations and discrepancies are the case, the standard must contain the required explanations and justifications.

In accordance with standards [2] and [3], an estimate of a dependability indicator is a numerical value of a dependability indicator calculated from sample data, while an estimation of a dependability indicator is an operation of obtaining (calculating) the numerical values of a dependability indicator from sample data. Thus, an estimate of a dependability indicator (or another parameter) is a random variable that can take different values from sample to sample. An estimation is done using statistical methods with the aim of obtaining an estimate of a dependability indicator (or parameter).

In this context, the terms “reliability estimate”, “tree estimate”, “gate estimate”, “dependability estimate” refer to properties, diagrams, devices and have special meanings that should be clarified.

In standard [4], Annex A.1.12, section “Statistical methods of estimating the probability of no-failure”, the terms “estimate of probability of no-failure”, “estimate of reli-

Table 2. Modification of the terms defined through “estimate”

Term used in the standard	Proposed term
1. Estimate of probability of no-failure	Calculation (computation) of probability of no-failure
2. Estimate of dependability indicators	Calculation (computation) of dependability indicators
3. Dependability indicators are estimated based on probabilities	Dependability indicators are calculated based on probabilities
4. Estimate of performance and maintainability indicators	Calculation (computation) of performance and maintainability indicators
5. Evaluated indicators	Computed indicators
6. Estimate of probabilistic characteristics	Calculation (computation) of probabilistic characteristics
7. Estimates based on state-transition diagrams	Calculations based on state-transition diagrams (using a state-transition diagram)

Table 3. Modification of terms defined through “definition”

Term used in the standard	Proposed term
1. Definition of availability coefficient	Calculation (computation) of availability coefficient
2. Definition of method	Substantiation (selection) of method
3. Defining average duration of states	Calculating (computing) average duration of states
4. Defining frequency of states	Calculating (computing) the frequency of states
5. Expression for defining average operation time	Expression (formula) for calculating average operation time
6. Formulas for defining dependability indicators	Formulas for calculating (computing) dependability indicators
7. Formulas for defining failure rate	Formulas for calculating (computing) failure rate
8. Probability definition	Calculation (computation) probabilities

ability indicators", "estimate of dependability indicator" are used correctly. However, at the same time, the use of the term "estimate" has nothing to do with statistics: "estimate of dependability indicators" (4.1), "estimate of dependability improvement" (4.1), "estimate of event characteristics" (4.4.1).

In most standards, in the "Terms and definitions" section, the concept of "definition" is used correctly, i.e., terms are defined.

However, in other cases, the concept of "definition" is used in a sense different from [12], i.e., nothing is actually defined.

It should be noted that in some standards the terms "estimate" and "definition" are used together. A simultaneous use of these terms is difficult to understand.

The meaning and content of some terms were examined in [10]. In this paper, the author relies on the terms substantiated in [10] and set forth in Table 1.

Results.

Thus, based on the requirements for term integrity and the terms examined in [10], the author proposed wordings of terms instead of those using the words "estimate" and "definition". Those wordings are shown in Tables 2 and 3.

The definitions of the terms in Table 1 are given in [10]. The meaning of terms in Tables 2 and 3 is so obvious that they need no definitions.

Discussion and conclusions

The use of the terms "estimate" and "definition" in some standards lacks integrity. The requirements of the standardization recommendations are not observed, the terms are not unambiguous and consistent with other standards.

It should be noted that along the state standards, these terms are used in technical documentation, science papers, monographs and textbooks.

The options proposed herewith should be considered as a tentative proposal. Final terms are to be developed through extensive discussion and a compromise solution.

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The author's contribution

The author conducted a terminological analysis of the standards that define the application of the terms "estimation" and "definition". As a result, terms have been identified that needed clarification.

Conflict of interests

The author declares the absence of a conflict of interests.