An analysis of basic interoperability related terms, system of interoperability types

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Interoperability on the infosphere is an increasingly significant prerequisite of information superiority. Information interoperability is not an autonomous concept, it has to be discussed in the framework of overall (operational) interoperability. In this paper we analyse definitions of the basic interoperability related terms, and suggest a general definition of interoperability. Then we discuss the relation of interoperability to concepts of compatibility, interchangeability, and commonality, and show that these are not levels of interoperability, but significant characteristics strongly connected with it. Finally we present a system model of interoperability types, introducing the concept of functional area interoperability, and describing the role of information interoperability, and technical interoperability.

1. Introduction

From the end of the 20th century, in the emerging Information Age, information and information capabilities possessed by different actors are increasingly significant resources used to effectively and efficiently fulfil their activities. The actors usually don't act alone, they can only achieve their goals in cooperation, coordinated with other actors. In addition to common goals, the most important elements constituting the foundation of cooperation are infosphere components: common and shared situational awareness, and plans. Moreover these elements require other knowledge components (e.g., concepts with common understanding, jointly accepted principles, and rules). So the goal-oriented use, and operation of cooperating partners' knowledge (information) and information processes require specific abilities, additional to their individual information capabilities.

Role of information capabilities necessary to cooperation is especially significant in execution of those complex operations that require coordinated actions of a mission-oriented and in many cases dynamically changing group of several actors. In military practice this significance has became essential with the appearing of the combined joint

task force (CJTF) concept, and operations other then war, where military organizations cooperate with a lot of other government or non-government (NGO, PVO) organisations.

Nowadays, in addition to human factors, the expertise and experience of military leaders and professionals participating in operations, information and other knowledge components embodied in IT applications already form one of the most important components of information capabilities. So to efficiently support military operations, to develop required information capabilities, and to gain and maintain information superiority in conflicts it is necessary to establish a task- and situation-oriented, information exchange among human actors, and IT components extending from exchange of raw data, to exchange of highly synthesized knowledge components.

Cooperation capability of actors in the infosphere, or interoperability is a frequently used, "popular" concept of our days' military literature and documents. A lot of publications discussed different aspects of interoperability, but only a few of them tried to use an all-embracing, system-oriented approach. The objective of this publication is to build a coherent conceptual foundation of and a framework for information interoperability. Section 2 summarizes definitions of basic terms related to interoperability as used in military documents, clarifies meaning and gives a general definition of interoperability, then reveals a conceptual misunderstanding regarding the relation of interoperability to three strongly related concepts: compatibility, interchangeability, and commonality. Section 3 classifies different types of interoperability, summarizes their main characteristics, and presents an overall system of them. Finally section 4 concludes the publication by briefly summarizing main results.

2. Analysis of interoperability related terms

In 1992, based on C4I experiences during Desert Shield/Desert Storm, interoperability has appeared as a basic type of capabilities necessary to efficient, and effective cooperation, in a vision document, "C4I for the Warrior", and has became an important concept of other military visions, doctrinal documents and directives. The meaning of this concept in military application, first connected mainly with technical aspects and interoperation between and among C4I systems, was gradually extended to organizations, groupings and forces.

This latter appears on security policy level in "Defence Capabilities Initiative", launched by NATO Heads of State and Government, at Washington in 1999. According to the first point "The objective of this initiative is to improve defence capabilities to

ensure the effectiveness of future multinational operations across the full spectrum of Alliance missions in the present and foreseeable security environment with a special focus on improving interoperability among Alliance forces, and where applicable also between Alliance and Partner forces."[1] The same has been formulated in the basic NATO publication providing 'capstone' doctrine of allied joint operations: "The effectiveness of Allied forces in peace, crisis or in conflict, depends on the ability of the forces provided to operate together effectively and efficiently. … A common doctrine supported by standardisation of equipment and procedures, validated through participation in joint and multinational training exercises, provides the basis for the formations and units of a joint and multinational force to be able to work together."[2]

2.1 Actual definitions of interoperability

The expression 'interoperability' appears in a dictionary of English language in connection with the expression 'interoperable', defined as "capable of being used or operated reciprocally."[3] In the dictionary, appearance of this expression is estimated to 1965-70, and the example used is 'interoperable weapons systems'.

Concept of interoperability appears in numerous – military and other – publications, documents also, obviously in many cases with different meaning or emphasis. Definitions are changing even in different versions of the same publication (e.g. glossary).[4] Let us enumerate the most important definitions to use as a basis for analysis with an attempt to formulate a generalized definition of interoperability.

"The ability of Alliance forces and, when appropriate, forces of Partner and other nations to train, exercise and operate effectively together in the execution of assigned missions and tasks."[5]

"The ability of systems, units or forces to provide services to and accept from other systems, units or forces and to use the services so exchanged to enable them to operate effectively together."[6]

"(Communications and Information Systems): Ability to provide services and information to and accept from other systems and to use the services and information so exchanged to enable them to operate effectively together."[7]

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[1] Defence Capabilities Initiative, Introduction, 1, p. 1

[2] *AJP-01(B)*, 0117. [pp 1-6, 1-7]

[3] *Webster's Encyclopedic Unabridged Dictionary of the English Language*, p. 997

[4] See for example AAP-6.

[5] *AAP-6 (V) mod 02*, p. 2-I-6 (after 15/7/2000).

[6] *AAP-6 (V) mod 01*, p 2-I-7; *AAP-31(A)*; *JP 1-02*, first definition ('operational' interoperability), p. 215

[7] *AAP-31*

"The condition achieved among communications-electronics systems or items of communications-electronics equipment when information or services can be exchanged directly and satisfactorily between them and/or their users. The degree of interoperability should be defined when referring to specific cases."[8]

"The capability to communicate, execute programs, or transfer data among various functional units in a manner that requires the user to have little or no knowledge of the unique characteristics of those units."[9]

Finally let see two definitions from the Hungarian military literature that are rather descriptive than definitive:

"An expression of ability to take part in international cooperation. Regarding to armed forces it supposes, that within a given coalition command and control, and armament of military organizations, expertise of personnel makes cooperation, communication between staffs, connections between (compatibility of) their weapon systems, coordinated system of supply with maps, ammunition, and fuel, etc. that is to say everything needed to reach the assigned objective possible."[10]

"For successful cooperation it is necessary common doctrinal base, mutual knowledge of capabilities of each other, required level of coordination, similar professional thinking, appropriate language practice, unified decision methods, and joint exercises."[11]

It can be seen from the definitions enumerated, that they describe different concepts, although all these concepts have common characteristics, so we can hypothesize, that these are different forms (types) of interoperability in general. The conclusion is that we need a more general definition of interoperability, a general concept that the concepts described in the above definitions are specialisations of.

2.2 General concept of interoperability

The definitions in the previous section show that interoperability has two basic characteristics. First it is a relation, a mutual capability between/among two or more objects.[12] Secondly it is a functional capability strongly connected with, and supporting cooperation. So the suggested definition of interoperability in general is the following:

Interoperability is a relation between/among objects, a mutual capability necessary to ensure successful and efficient interoperation, supporting cooperation.

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[8] *JP 1-02*, second definition ('technical' interoperability), p. 215

[9] *ADatP-2 (H)*, 01.01.47, p. 2-1-4, ISO/IEC 2382-1, 01.01.47, p. 12

[10] *Hadtudományi Lexikon*, p. 596

[11] *Katonai Kislexikon*, p. 23

[12] It can also be defined as an individual capability with respect to a given base (e.g. NATO-interoperability).

To fully understand the meaning of interoperability we should analyse the relation between cooperation, and interoperation. Based on the commonly accepted meaning of the two terms,[13] it should be clearly stated that they are not synonyms. Cooperation includes existence of a common goal, consciousness, deliberateness, and agreement, but interoperation by all means does not. So on the basis of all these, interoperability as a capability to interoperate, is a necessary but not sufficient condition of cooperation.

Subjects of interoperability – appearing in the definitions – are active objects that can be grouped into two basic types: organised groups of humans acting consciously (forces, groupings, organisations, etc.), or technical systems operating purposefully (equipments, functional units, etc.). Accordingly, we can differentiate interoperability between/among actors and between/among equipments. In the military literature these to types are most frequently called operational interoperability and technical interoperability, respectively.[14]

The two types, although they have many similarities, have significant special characteristics as well that we shall examine in detail later. From the two, operational interoperability plays the primary role, and technical interoperability is subordinated to it. The later is necessary just to create the conditions for the cooperation between/among actors, because successful and efficient cooperation requires not only interconnection and harmonization of traditional organizational processes, but also those of implemented or supported by technical systems.

In consequence of revolutionary improvement of information technology, spreading and growing importance of information activities, functions and devices, the role, importance and some characteristics of technical interoperability have changed. In addition to interoperability between devices supporting interoperability and being resources of particular actors, another type of technical interoperability has appeared between equipments of an actor and the systems of the information environment.

Technical interoperability between an actor and his/her environment basically does not differ in nature, but is essentially different in purpose with respect to interoperability immediately between the actors. In contrast with the later, the purpose is not to support a higher level (e.g. operational) interoperability, but to improve efficiency of actor's activity based on better utilization of possibilities, resources and services provided by the environment.

In case of systems in the information environment it has generally no importance of knowing their owners, only the services (information, and information processing,

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[13] Cooperate ~ 1.) to work or art together or jointly for a common purpose or benefit. 2.) to work or art with another or other persons willingly and agreeably. *Webster's*, p. 446

[14] See for example in *Realizing the Potential of C4I*, Chapter 2.

information transmission functions) are important. Although the use of these services, whether for payment or free of charge, means a kind of cooperation between the consumer and the provider, nowadays this happens more and more "impersonally", in an automated way.

Another special feature of the infosphere is that based on results of research in artificial intelligence and developments in AI tools; in addition to traditional actors (individuals, groups of persons, organisations), there have appeared the artificial "actors", so called intelligent agents, having high level autonomy, independent intelligence and communicative capability.

To fully understand the meaning of interoperability, we should at last examine what are the possible actors and devices taking part in interoperability relations. As we have already stated, interoperability of actors and devices is a prerequisite of cooperation between any groups. Despite this, we usually do not call capabilities to interoperate – although they fulfil requirements of definitions – as interoperability between organizational units of a given organisation, or between functional units of a given device.

In case of these examples, the organisational units, devices or functional units were originally created, established to operate as part of the given organisation, system or device, to satisfy predetermined detailed functional and other requirements. Whereas the use of expression 'interoperability' is most common in cases, where detailed conditions of interoperation are not given in advance and forever, and when the given organisational units or devices have to operate as part of a heterogeneous and, in most cases, dynamically changing system.

2.2 Compatibility, interchangeability, commonality

There are some other concepts – namely compatibility, interchangeability, and commonality – strongly connected with concept of interoperability. From the three, compatibility appears most frequently together with,[15] and often as a synonym of,[16] interoperability. According to a basic NATO publication (regarding CIS systems):

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[15] See for example the following documents, published by US Department of Defence: *DoD Directive 4630.5*, *DoD Directive 4630.8*.

[16] For example: "Changes … will require ample justification based on technical, performance, *compatibility (*e.g. *interoperability)*, and security criteria." (emphasis by the author), *NATO C3 Technical Architecture Volume 1, Management*, V2.0, p. 21

"In ascending order, the levels of interoperability are compatibility, interchangeability, and commonality." The definitions of the three concepts in NATO glossary are given in the following format:[17]

"Compatibility: The suitability of products, processes or services for use together under specific conditions to fulfil relevant requirements without causing unacceptable interactions." (ISO-IEC)[18]

"Interchangeability: The ability of one product, process or service to be used in place of another to fulfil the same requirements."[19]

"Commonality: The state achieved when the same doctrine, procedures or equipment are used."[20]

Based on these definitions we should say that these concepts – with the given meaning – couldn't be considered different versions of interoperability, they are only essential characteristics, capabilities from the point of view of interoperability.

The above definition of compatibility corresponds the primary meanings of the original English term[21], but this is not more than a "capability to operate side by side". In this sense – that appears for example in the expression 'electromagnetic compatibility'[22] – two, or more device, process can be, or are compatible, despite they neither can "cooperate" in any way, nor they are planned to do so (e.g., a radar equipment, a medical diagnostic device, and a mobile phone set).

The expression compatibility has also other meanings: some of them express an ability to use as part of a system; others express the ability of interchangeability.[23] There are other interpretations of compatibility in information technology, or informatics. One of them is the capability of two devices to substitute functionally for each other.[24] The other is an essentially or fully identical functional capability of two

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[17] Definitions have date indication 15/7/2000. In previous versions of AAP-6 there were definitions with basically the same content. The same definitions can be found in different versions of AAP-31 too.

[18] *AAP-6(V) mod 2,* p. 2-C-8

[19] *AAP-6(V) mod 2*, p. 2-I-5

[20] *AAP-6(V) mod 2*, p. 2-C-8

[21] compatible ~ 1.) capable of existing or living together in harmony. 2.) able to exist together with something else. *Webster's*, p. 417

[22] The ability of equipment or a system to function in its electromagentic environment without causing intolerable electromagnetic disturbances to anything in that environment. *AAP-6(V) mod 2*, p. 2-E-1

[23] compatible ~ 4.) (computers) (of hardware) capable of being connected to another device without the use of special equipment or software. 5.) (electronics) (of a device, signal, etc.) capable of being used with equipment in a system without the need for special modification or conversion. 7.) something, as a machine or piece of electronic equipment, that is designed to perform the same tasks as another, often in the same way and using virtually identical parts, programmed instructions, etc. [*op.cit.*]

[24] compatibility ~ 1.) (of hardwer) The ability of a subsystem (e.g. memory) or an external device (e.g. terminal) to be substituted for the originally designated equipment. *Dictionary of Computing*, p. 69

devices, or two versions of a family of devices (e.g. to run software on them without any change).[25] And the third is a capability to meet specifications of a given connectivity standard.[26] An other definition summarizes the variety of meanings in the following form: "An ability to express cooperation, interchangeability or interconnectivity of two device, equipment, apparatus, program."[27]

With respect to interchangeability, and commonality it should be established, that they essentially do not mean capability of two objects to interoperate. In general they can be even used to describe a relation between passive objects, as the following technical-oriented definitions from a related publication demonstrate.[28] In case of active objects it is easy to see, that if an object is capable to interoperate with a third one, than this will also valid for the second, interchangeable with the first object.

In summary it should be stated, that compatibility, in its restricted sense, interchangeability, and commonality essentially are not lower level realizations of interoperability, but mutual capabilities – between the subsystems, elements of two system – to support implementation of interoperability. To reach interoperability between two systems has usually require mutual use of each other's devices, systems, and exchange of elements, subsystems, and supplies between these devices, systems.

3. System of interoperability types

'Interoperability' appears in many expressions with different attributes, that indicate different types, or components of interoperability, being in connection with, based on each other. All of the definitions listed in Section 2.1 describe 'interoperability' without any attribute, but actually they are definitions of different types of interoperability, so

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[25] compatibility ~ 2.) (of software) The ability of a computer to directly execute a program code that was compiled, assembled, or written in machine language for another computer. *Doctionary of Computing*, p. 69
compatibility ~ Two computers are compatible if a program developed for one of them can be executed on the other without any modification. KOVÁCS, p. 531

[26] The capability of a functional unit to meet the requirements of a specified interface without appreciable modification. *ISO/IEC 2382-1*, 01.06.11; p. 21

[27] KOVÁCS, p. 531.

[28] Interchangeability: A condition which exists when two or more items possess such functional and physical characteristics as to be equivalent in performance, fit and durability, and are capable of being exchanged one for the other without alteration of the items themselves or of adjoining items, except for adjustment. *DoD Directive 2010.6*, Enclosure 2 – Definitions

Commonality: A quality which applies to material or systems possessing like and interchangeable characteristics enabling each to be utilized or operated and maintained by personnel trained on the others without additional specialized training; having interchangeable repair parts or components; and applying to consumable items inter-changeably equivalent without adjustment. *DoD Directive 2010.6*, Enclosure 2 – Definitions, JP 1-02, p. 83

we should carefully distinguish between them. In addition to operational interoperability and technical interoperability we have already mentioned, in the military literature appear command-and-control (C2) interoperability, intelligence interoperability, logistics interoperability, and information interoperability. In this section we will classify these types, and describe a system of them.

Role and significance of different interoperability types are not the same, so at first we should determine the one that has primacy. It is commonly accepted that operational interoperability plays primary role among interoperability types, because the common purpose of them is to support cooperation. This primary concept that appears in AAP-6 and AJP-01, in a most universal way can be defined as follows:

Operational interoperability is a relation between/among actors cooperating to achieve a common goal, an overall, mutual capability necessary to ensure successful and efficient cooperation.

Successful and efficient cooperation is founded on continuous harmonization of goals and situational awareness, coordinated planning and execution of common activities that require systematic information exchange (communications) and a shared ontology (system of concepts) as a base of all these. In the course of these common activities information, material goods, and services flow between the cooperating partners.

3.1 Functional area interoperabilities

The most comprehensive version of interoperability between cooperating actors demands an appropriate level of interoperability in every functional area, because an efficient cooperation is not possible without required level of harmonization between appropriate organizational functions (functional processes). According to this fact, interoperability can be defined regarding any functional area as a mutual capability to cooperate in this area.

A functional area interoperability is a relation between/among actors cooperating to achieve a common goal, a mutual capability necessary to ensure successful and efficient cooperation in a given functional area.

Different functional area interoperability types have different significance. The primary role by all means belongs to command and control (C2) interoperability, because the C2 processes create and maintain basic conditions of cooperation between actors. The second group contains those functional area interoperability types that are

connected with basic organizational processes, specific for the given actor.[29] And finally the third group contains functional area interoperabilities common to all actors, related to general organizational areas (logistics, human resource management, etc.).

C2 interoperability is a mutual capability of actors to ensure linking of their command and control processes, harmonization of common goals and situational awareness, and coordinated planning and execution of the necessary activities. As we have already said, information exchange (communication) between actors, and common understanding of information so exchanged, at least on a level required by cooperation, is a fundamental condition for all of these. Because information exchange cannot be restricted to C2 processes, it seems necessary to introduce a broader concept of information interoperability. So C2 interoperability can be considered as a special type of information interoperability, limited to exchange of C2 information.

Other important functional component of operational interoperability between cooperating actors is logistics interoperability that can be defined as follows.

Logistics interoperability is a mutual capability of different actors necessary to provide and use logistic services.

According to an earlier, narrower interpretation, logistic (!) interoperability "will often be achieved by making such assemblies, components, spares, or repair parts interchangeable, but can sometimes be a capability less than interchangeability when a degradation of performance or some limitations are operationally acceptable".[30] A most recent NATO interpretation states that minimum objectives needed are "interoperability of the principal equipment, interchangeability of supplies and commonality of procedures".[31]

Logistics interoperability – in addition to information type interoperabilities – from the beginning has played an important role. This is demonstrated in a DoD directive issued in 1980 where the five top priority areas of interoperability and standardization are: command, control, and communications systems; cross-servicing of aircraft; ammunition; compatible battlefield surveillance/target designation/acquisition systems; interoperability and standardization of components and spare parts.[32]

Other individual functional area interoperabilities usually have less common, general characteristics. This is because the cooperation in certain functional areas –

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[29] Such can be for example: air defence interoperability, engineering interoperability, or ABC defence interoperability, but instead of them usually the "interoperability of/in air defence, engineering, ABC defence" expressions are used.

[30] *DoD Directive 2010.6*, Enclosure 2 – Definitions.

[31] *NATO Handbook*, 1998, p. 176

[32] *DoD Directive, 2010.6*, D. Policy, 2. Priorities.

except for economic sphere – is in most cases founded on information exchange connections. So these functional area interoperabilities are essentially identical to information interoperability pertaining to the given functional area. A functional area interoperability includes, and assumes interoperability of actors (organizations, individuals) within the given area, and the required level of interoperability between actors of the given area and actors of other areas.[33]

In military practice, in addition to C2 and logistics interoperability, a third type of interoperability plays also an important role. This is intelligence interoperability, an interoperability on a primarily informational area. Its role is symbolised by the fact, that in the Joint Doctrine Encyclopedia the two subheadings of 'interoperability' are: Intelligence interoperability, and Command, Control, Communications, and Computer (C4) Systems Interoperability.[34]

3.2 Information interoperability

The expression 'information interoperability', in this form, appears rarely in military literature, but we can find it in a new policy guidance document published by DoD Chief Information Officer (CIO), that supersedes former directives on C3I systems interoperability questions:[35]

Information interoperability: The condition achieved when information is electronically exchanged and used to enable the capabilities and/or users to operate effectively together.[36]

In contrast with this definition, in my opinion, the content of information interoperability cannot be narrowed to electronic information exchange. The requirement of interoperability in reality extends to any – in between traditional – form of information exchange between given actors, needed for their cooperation. Obviously the role of electronic information exchange continually grows, as use of IT devices and systems, and other devices capable of automated information exchange become widespread, but this role probably will never exclusive. A similar idea has appeared in a conference

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[33] See the presentation cited already: "Interoperability of Árpád system with respect of procedures was examined in to relations: … interoperability of Árpád with field artillery fire control systems of other NATO nations; …interoperability of Árpád with non-artillery (e.g. manoeuver) forces of other NATO nations." KENDE, p. 92

[34] See: "Interoperability" in *Joint Doctrine Encyclopedia*, pp. 352-354

[35] *DoD Directive 4630.5*, and *DoD Instruction 4630.8*.

[36] *DoD CIO Gudiance and Policy Memorandum No. 1-8330-052899*, 4. Definitions. – Definition of 'capability' in the same document is the following: "Any information technology and National Security Systems (Public Law 104-106) that enables or supports the production, use, or exchange of information, in any form electronically."

presentation dealing with interoperability of artillery fire control.[37] So we suggest a more general definition, and the later parts of this publication will be based on the following:

Information interoperability is a mutual capability of different actors necessary to ensure exchange and common understanding of information needed for their successful cooperation.

As follows from the above definition, information interoperability – and at the same time C2 interoperability – have two basic components: ability to exchange information, and ability to develop a common, shared interpretation of this information. In the professional and popular literature there are other expressions connected with information interoperability, such as: language interoperability, conceptual interoperability or intellectual interoperability. The first one, which is the required level knowledge of the language used in communication, is a natural prerequisite of information exchange.

Conceptual interoperability is the identity, or equivalence of concepts, conceptual systems of actors, that is also a fundamental condition of information exchange. Intellectual interoperability is used in the sense of identity, or similarity of thinking of actors sufficient for cooperation.[38] In case of military operations these two requirements appear in the necessity of common, unified doctrine, and the mutual knowledge of the individual service and national procedures.[39] Conceptual, and intellectual interoperability, and appropriate level of mutual understanding embodied in them can evolve and be consolidated only in practice, in case of military operations only in the course of joint and multinational exercises.

To emphasize statements done before, we should point out again that any use of expression 'interoperability' is reasonable only in situations, where there are some types of heterogeneity. It is not necessary to emphasize conceptual interoperability between experts of a given speciality using a common ontology, to talk about language interoperability between individuals using the same language, and to analyse

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[37] "These interoperability capabilities can be implemented in two way: using traditional (non-automated), or automated methods." KENDE, p. 93

[38] One of the components of intellectual interoperability gaining growing importance nowadays is cultural interoperability.

[39] "A common doctrine supported by standardisation of equipment and procedures, validated through participation in joint and multinational training exercises, provides the basis for the formations, and units of a joint and multinational force to be able to work together." *AJP-01(B)*, Chapter 1, 0117., p. 1-7

"Mutual understanding also rests on a common application of joint doctrine. … A common approach should be inherent in thought and practice." *AJP-01(B)*, Chapter 4, 0409, p. 4-3

interoperability between identical IT systems. These examples show, that interoperability and heterogeneity are strongly connected concepts, presuming each other.

Based on the discussions done so far, we can describe a three-level model of interoperability types, shown in Figure 1.
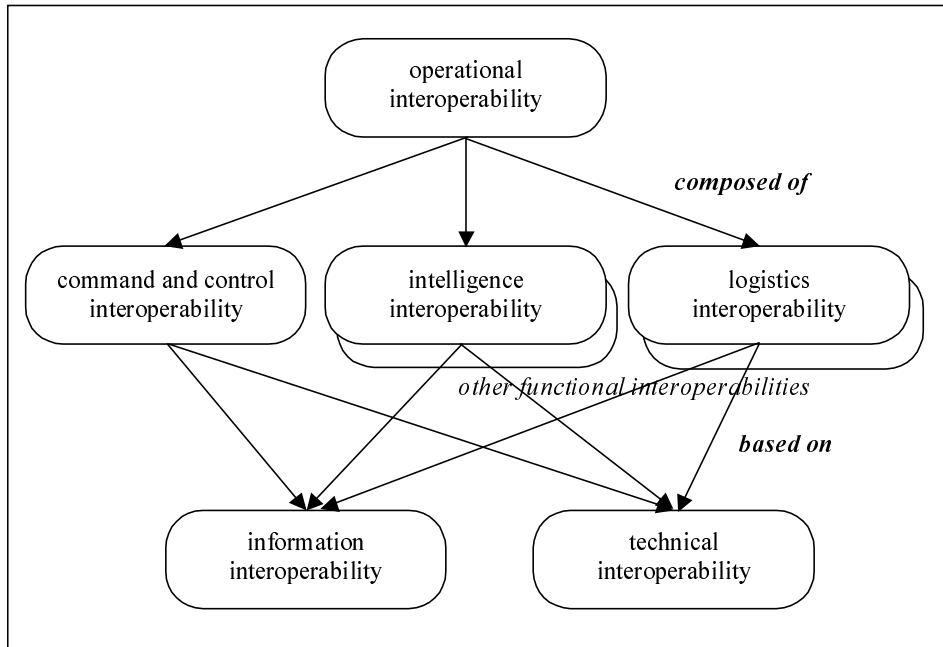
Figure 1: System of interoperability types

Operational interoperability is at the top level and functional area interoperabilities form the intermediate level. The model shows that operational interoperability is composed of the different functional area interoperabilities. Finally two interoperability types are at the base level. Any other interoperability is based on information and technical interoperability. The role and necessity of information interoperability is

unquestionable, because there is no functional cooperation without information exchange. The role of technical interoperability is also very important in a world, where technical systems, equipment and devices support almost all functional processes.

4. Summary

Information superiority is enabled and supported by an interoperable network of C4I systems: a globally interconnected, end-to-end set of information capabilities, associated processes, and personnel to manage and provide information on demand of warfighters, policy makers, and supporting personnel. Interoperability of C4I systems is a key enabler of force integration, fusing of different services, and coalition partners with heterogeneous and disparate capabilities, equipment, knowledge, and procedures into a unified military force that achieves high military effectiveness, exploiting and coordinating the individual force capabilities. So information interoperability is one of the most significant components of overall interoperability and has an increasingly growing importance.

Interoperability, in general, is a concept of increasing importance, it appears and gets growing significance in almost every basic military vision, concept, or doctrinal document. It has defined in many documents, among others in military glossaries, but these definitions are rather different both in level, and in meaning. In this publication we have analysed the basic interoperability related terms in the military literature, created some new, more general definitions, and highlighted that interoperability is strongly connected to heterogeneity. We tried to prove that, in contrast to statements in doctrinal documents, concepts of compatibility, interchangeability, and commonality are not levels of interoperability, but significant characteristics strongly connected with it. And finally we surveyed the list of different interoperability types, classified them, created the concept of functional area interoperability, and determined a system of interoperability types.

The results form a base to further investigate information interoperability, to analyse its components, and tools and methods necessary to achieve it, especially semantic interoperability. It should be the subject of an other publication, to summarize basics of semantic questions regarding military domain knowledge; to explore different types of semantic heterogeneity between – military and non-military – IT systems used in military operations; to analyse domain concepts in different military areas, and build appropriate domain ontologies; and to develop framework, methods and tools to ensure semantic interoperability in modern military operations of our age.

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The work presented in this publication is strongly connected with, and includes results reached in the framework of an OTKA sponsored research (T 030674) on system and attributes of information used in national defence.

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