

# Knowledge Acquisition in Tactical Command and Control Systems

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**Abstract.** *Ontology is the philosophical study of the nature of being, existence or reality in general, as well as of the basic categories of being and their relations. Traditionally listed as a part of the major branch of philosophy known as metaphysics, ontology deals with questions concerning what entities exist or can be said to exist, and how such entities can be grouped, related within a hierarchy, and subdivided according to their similarities and differences.*

*The principal questions of ontology are "What can be said to exist?" and "Into what categories, if any, can we sort existing things?" Various philosophers have provided different answers to this question.*

*One common approach is to divide the extant entities into groups called categories. Of course, such lists of categories differ widely from one another, and it is through the co-ordination of different categorial schemes that ontology relates to such fields as theology, library science and artificial intelligence.*

*The paper describes objectives and possible solutions of the project dealing with the ontology of GF-TCCS (Ground Forces Tactical Command and Control System) and AF-TCCS (Air Forces Tactical Command and Control System).*

## Keywords

Ontology, NEC, Topic maps Tactical Command and Control Systems, Ground Forces Tactical Command and Control System, Air Forces Tactical Command and Control System.

## 1. Introduction

Although ontology could be perceived as the philosophical branch, this term is also used in information science. In the context of information science ontology means "formal, explicit specification of a shared conceptualization" (1) (Gruber, 1993).

Ontology of Tactical Command and Control Systems is a part of a research project "Czech Army Network Enabled Capability (NEC) Knowledge Management", of the Faculty of Military Technology at the University of

Defence in Brno, the Czech Republic. The aim of this research project is to provide system support of the NEC concept.

One of the goals of this project is to analyze possible knowledge approaches and to consider suitability of these approaches for the Czech Army. One of the possible approaches is to design ontology using topic maps. This article shows possible solution of creating an ontology using topic maps.

## 2. Digitalization of battlefield

One of the basic transformation aims of ACT (**Allied Command Transformation**) is information superiority and achievement and ability in the net interconnected environs (IS&NEC). This is relevant especially for the command and control devices. The key aspect of NEC (or NNEC) will be the analysis of decision making processes of distributed **command and control systems (C2)** of the net interconnected environs.

The digitalization of battlefield is a current trend of developing the armed forces, especially the armed forces of NATO members, controlled from the position of the central NATO bodies and individual national forces. The digitalization of battlefield is a fundamental trend, which influences the development of command and control systems C4ISR. The digitalization of battlefield will give us the ability to connect weapon systems on the basis of computer control systems.

## 3. Topic maps overview

Topic maps are a standard for the representation and interchange of knowledge. The standard is formally known as ISO/IEC 13250:2003. Topic map represents information using topics, associations and occurrences - the TAO of topic maps (ii)(Pepper, 2000).

Topic is a representation of any concept. It could be anything – person, location, thing, event, file etc. The term itself refers to the element of the topic map that represents

the subject – the part of the real world that we describe in the topic map.

Topics can be categorized according to their types. These categories are called topic types. Any topic is an instance of its topic type. Topic type itself is defined as a topic.

The standard defines topic name – a topic can have multiple topic name, each name with different types of name (base name, display name, sort name). According to this it is obvious that unambiguous identification is required. The solution of this problem is to use unique identifiers. We distinguish two types of identifiers:

- subject locator - subject is an information source addressable for example by URL (<http://www.wikipedia.org>)
- subject identifier - subject is not an information source, addressable only implicitly for example city of Zadar can be uniquely identified by information source (<http://en.wikipedia.org/wiki/Zadar>)

To make global sharing of topic maps possible we use Published Subject Identifiers (PSI) – for example <http://psi.ontopedia.net>.

Association represents the relationship between topics. Associations can be grouped according to their types to association types. Similarly to topics, association itself is defined as a topic. Each topic that is a part of an association plays a role. These association roles have also their types defined as topics. The very important thing about associations is that they are not oriented. The directionality is substituted by roles.

Occurrences describe relationship between topics and information resources relevant to these topics. We distinguish internal (inside of the topic map) and external resources (outside of the topic map). Occurrences have their types that are topics.

## 4. The Ontology of GF-TCCS

**Ground Forces Tactical Command and Control System (GF-TCCS)** is a great project, which not only implements the latest technologies and technical devices but is also an instrument for the necessary change of style and working activities of commanders and their staffs. It is consequently a tool for optimizing their structures, too. The GF-TCCS provides commanders and staffs on the operational tactical level with support in the decision making process. The commanders and staffs are supported in the effective preparation of necessary documents. All this enabled commanders and staffs to be prepared for the combat control in the peacetime. The main aim of GF-TCCS is to support command and control systems automated function on the operational tactical level and all

supported functions in the field conditions and in the regime, which is close to the real time.

The GF-TCCS (Ground Forces Tactical Command and Control System) serves - as an integrated and automated system of command and control of ground forces - for providing the automated support to the commanders and their staffs in accordance with the assigned tasks and operation phases. It also serves for the collecting of information starting from the lowest tactical levels up to the operational ones. It consists of several subsystems and one of them is the automated system of combined arms command and control.

**The GF-TCCS consists of the following general modules:**

- Main module
- Specialized module.

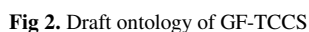
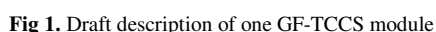
**Each module consists of the following general subsystems:**

- Core-Forming General Subsystem (SC2IS)
- Battle Management Vehicular Information Subsystem (BMVIS)
- Special Information Subsystem (SPEC)

The significance of ontology lies in improving the co-operation of software systems and system engineering. Therefore ontology brings the possibility to unite approaches and maintain consistence and clarity.

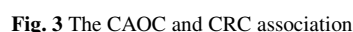
In the long-term it is taken into account to develop the ontology of all GF-TCCS system, which would cover the area of our interest. In the first place it would enable the classification of objects which we work with, such as html pages, documents and texts, pictures, graphs, presentations, conference papers, etc. The use of ontology is basically inevitable as the GF-TCCS is quite extensive and consists of large amount of dependent and independent modules. It is necessary in a dynamically changing system to have the individual modules and their contents precisely semantically labelled. Only such labelling can guarantee that the data will not be misinterpreted.

The analyses and proposals of GF-TCCS (global and detail ones) are classified documents and therefore it is not easy to describe the system in detail and at the same time do not break the law on the security of classified information. It is not so difficult if the proposal of ontology is correct. Therefore it took me over 2 months to choose unclassified information and documents for the ontology of GF-TCCS.



This part of the article presents parts of the topic map modeling the AF-TCCS. A free generic application Ontopia Knowledge Suite (OKS) Samplers is used to create topic map of AF-TCCS.

The main task of the Czech Air Forces is to secure the national airspace (Air Policing) as a part of the North Atlantic Treaty Organization (NATO) Integrated Extended Air Defense System (NATINEADS). Effective air defense is fundamental to NATO security. The NATO airspace is divided into Air Patrol Areas (APA). Each APA has its Combined Air Operations Centre (CAOC). The Czech Commanding and Reporting Centre (CRC) is a subordinate to CAOC-4. Figure 3 represents these topics and their associations. Figures were created using Ontopia Vizigator.



The Czech CRC is commanding and controlling the Quick Reaction Alert Forces (QRA). In the Czech Republic the QRA Forces are stationed at Air Force Base Čáslav. The base is equipped with JAS-39 Gripen and L-159 Alca jets. These topics and their associations represents figure 4. Take notice of not oriented associations. Roles represent the orientation of these associations. As you can see topics may play different roles in different associations.



**Fig. 5** Context of AF-TCCS within the Czech Army

The Ontology of Tactical Command and Control Systems is part of a research project “Czech Army Network Enabled Capability (NEC) Knowledge Management”, of the Faculty of Military Technology at the University of Defence in Brno, the Czech Republic.

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## About Authors

**Jaroslav Smetana** was born in Hradec Králové, Czech Republic. The author currently serves as a communication officer of the Čáslav Air Force Base. The areas of his research are Knowledge Systems, Military Communication Systems, Command and Control Systems.

## 6. Conclusion

The aim of this article is to show the possibility of building ontology using topic maps. Due to their generality and expressive power topic maps give us the ability to control information glut, share knowledge effectively and in understandable way. They are able to connect information from many different sources. Identity model of topic maps