

# NEC Ontology

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**Abstract.** *The paper deals with the latest progress in development of Defence Research Project MENTAL. Results of this project should advance better understanding of NATO NEC Principles and Information Management in the CIS area in the Czech Army. The core of this solution is a knowledge portal in the NEC area. Creating basic ontology of the mentioned domain becomes a very important stage on the way to develop this portal. The paper describes the current version of the NEC ontology.*

## Keywords

NEC, NNEC, Information Management, Information Sharing, Ontology, Taxonomy, AtoM, AION Topic Maps.

## 1. Introduction

The Defence Research Project MENTAL is one of several projects currently in progress belonging to the area of Network Enabled Capabilities (NEC) for the Czech Army (hereinafter ACR). Among other projects, also SIMNEC, SOANEC, SOSNEC and TACOMNEC projects can be mentioned. The main purpose of our MENTAL project is to create terminology for better understanding of the NEC area (domain).

Our work consists of knowledge process analysis approaches, definition of ontologies using ontology languages to assess their suitability for the use in the ACR. One part of this solution is also aimed at assessing the state of security issues and solutions of NEC for the ACR. We need to formalize NEC strategy to develop conceptual schemes and ACR Encyclopedia of NEC. We want to propose a methodology for creating knowledge-based systems in the Army. One of the most important parts is the developing of three ontologies: NEC (the basic one described below), Operational and Tactical System for Command and Control, and NEC Security issues.

## 2. Ontology definition

There is no one exact definition of this term. Mostly - ontology is an explicit specification of a conceptualization. The term “conceptualization” is defined as an abstract, simplified view of the world, which needs to be represented for some purpose. It contains the objects, concepts, and other entities that are presumed to exist in some area of interest, and the relations among them. The term “ontology” is borrowed from philosophy, where ontology is a systematic account of existence.

Ontology is knowledge represented formally by a set of concepts within a domain and the relationships between those concepts. It is used to reason about the properties of that domain, and may be used to describe the domain. Ontology defines concepts, providing a way to move towards consistency in vocabulary. It provides a working model of the entities and interactions of a particular topic. Ontology shows the relationships, properties and functions between terms or concepts which can express much wider range of relationships between attributes or terms than a simple hierarchy.

Classes are in focus of most ontologies. Classes describe concepts in the domain. A class can include subclasses that represent concepts which are more specific than a superclass. In practical terms, the developing of ontology includes:

- defining classes in the ontology,
- arranging the classes in a taxonomic (subclass-superclass) hierarchy,
- defining terms and describing allowed values for these terms (called slots),
- filling in the values of slots for instances.

We can then create a knowledge base by defining individual instances of these classes filling in specific slot value information and additional slot restrictions.

### 3. Procedure of Ontology development

Ontology defines a common vocabulary for researchers who need to share information in a domain. It includes machine-interpretable definitions of basic concepts in the domain and their mutual relations. Reasons for developing ontology:

- To share common understanding of the structure of information among people or software agents.
- To enable reuse of domain knowledge.
- To separate domain knowledge from the operational knowledge.
- To analyze domain knowledge.

Developing ontology is similar to defining a set of data and their structure for other programs to use. Problem-solving methods, domain-independent applications, and software agents use ontologies and knowledge bases built from ontologies as data.

Some ontology-design ideas are based on object-oriented design. However, ontology development is different from designing classes and relations in object-oriented programming. Object-oriented programming concentrates on methods within classes - a programmer makes design decisions based on the operational properties of a class, whereas an ontology designer makes these decisions based on the structural properties of a class. *There is no single correct ontology-design methodology!*

In information management and knowledge systems area the term "taxonomy" is also used frequently. What is the difference between taxonomy and ontology? Ontologies imply a broader scope of information - ontology might encompass a number of taxonomies, and each taxonomy organizes a subject in a particular way. Both ontologies and taxonomies can track key words, but ontology is likely to classify these words more carefully.

### 4. Ontology Visualization Techniques and tools

Several approaches are currently used to address this issue:

- The first approach categorizes visualization methods based on two criteria, the data-type of the objects to be represented in the interface (linear, planar, volumetric, temporal, multidimensional, tree, network, workspace) and the task typology (overview, zoom, filter, details-on-demand, relate, history, extract).
- 3D approach distinguishes three general categories: mappings from the data domain to the visualization space (surface plots, cityscapes, etc.), information presentation techniques (perspective walls, cone trees, etc.) and dynamic information visualization

techniques (fish-eye views, self organizing graphs, etc.).

Developers and investigators have available a wide range of Ontology Management and Development Tools – *Protégé 2000*, *Web Ontology Language (OWL)*, *OilEd*, *Apollo*, *RDFedt* and *OntoLingua* can be mentioned as examples.

### 5. NEC Ontology

There is no one "correct" way or methodology for developing ontology - no one correct way to model a domain. Ontology development is necessarily an iterative process. Concepts in the ontology should be close to objects (physical or logical) and relationships in the domain of our interest. These are most likely to be nouns (objects) or verbs (relationships) in sentences that describe our domain.

We have started the development of our NEC ontology by defining its **domain** and **scope**. We have answered several basic questions:

- What is the domain that the ontology will cover?
- What are we going to use the ontology for?
- For what types of questions should the information in the ontology provide answers?
- Who will use and maintain the ontology?

The answers to all these questions may change during the ontology-design process (and they really do!), but at any given time they helped us to limit the scope of our model.

NEC area is a very complex and complicated topic - it is closely connected with:

- Communication and information technology
- Sensors for weapon systems
- Command and control processes, and sometimes underestimated:
- Attitude of people!!

It covers a large number of army activities and technology system development, and the expected later use of NEC means will make significant changes to crucial command and control processes. Therefore we had to consult a number of issues during the development of our ontology with army officials (MoD and General Staff). As we expect - they will be the main users of NEC knowledge portal after finishing our project activities

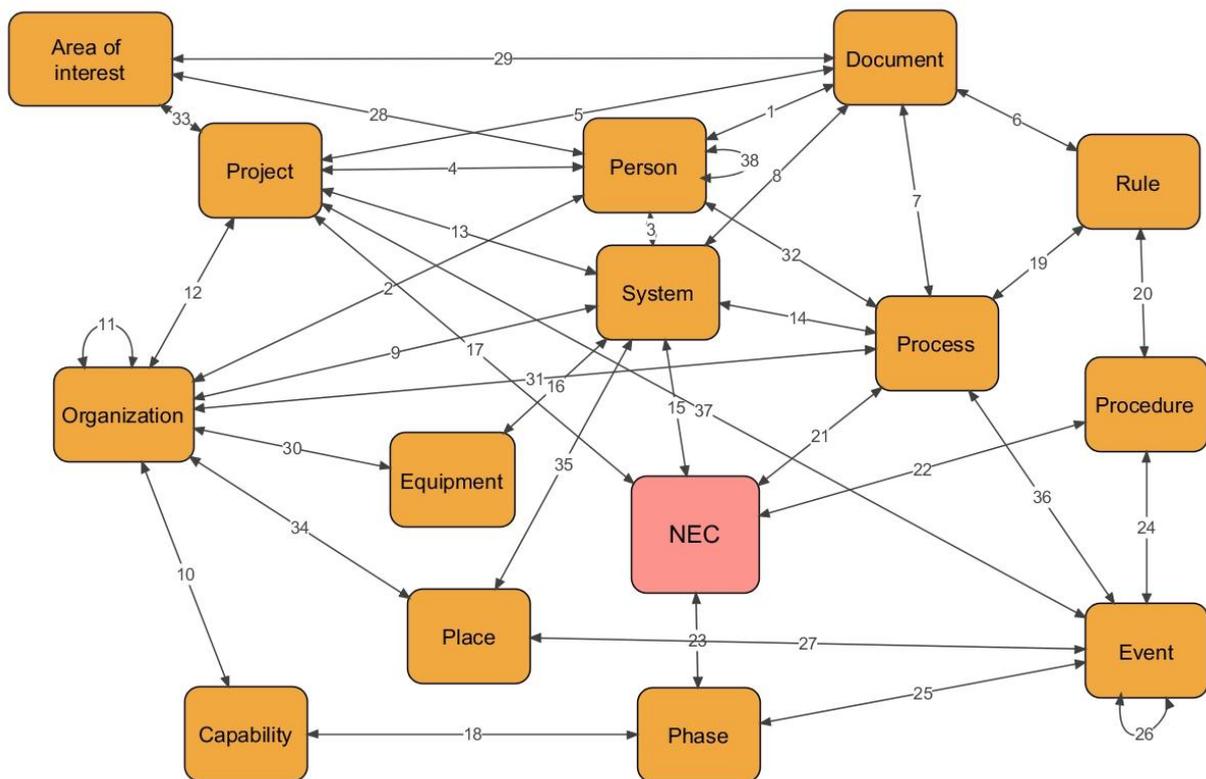


Fig. 1. NEC Ontology

During the development of our ontology we had to consider (and to define) the following areas:

- scope of our interest – we had distinguished 19 main items:
  - doctrine, strategy
  - stages
  - personal area
  - infrastructure
  - logistics
  - intelligence
  - interoperability ...,
- organizations, units, personnel (users),
- processes, procedures and capabilities,
- rules and relationships,
- projects, documents,
- stages, events,
- armaments, sensors, ...

From all these considerations (and after quite long expert discussions) we chose 14 main elements as shown in Fig. 1. The elements are connected by numbered links expressing relationships among particular elements. Example:

- Link no 1 PERSON Is author (creator) of DOCUMENT
- Link no 2 PERSON Is member of ORGANISATION

For every basic element we have defined detailed characteristics and attributes - as shown in Fig. 2.

These are the most important achievements connected with NEC ontology. We have already used some highly sophisticated software technology tools. We cooperate with well known companies in this branch in the Czech Republic - Tovek Company (Prague) and Aion (Zlin). Our goal is to develop the NEC Knowledge Portal where all results connected with NEC activities and processes in the Czech Army, and NATO as well, will be available for army officials (involved in NEC area) in a very sophisticated form.

As an example we can show the upper part (Classes) of our NEC data in specialized software tool AtoM (AION Topic Maps) – see Fig. 3. Following parts are Groups, Associations and Properties.

Attribute:			Concept (Class):										
No	Attr Name	Data type	PERSON	ORGANISATION	DOCUMENT	RULE	ARMAMENT	PROCESS	PROJECT	EVENT	PLACE	TOPIC	STAGE
1	name	text	♥	♥	♥	♥	♥	♥	♥	♥	♥	♥	♥
2	name in English	text		♥	♥	♥	♥	♥	♥	♥	♥	♥	♥
3	place	text			♥		♥			♥			
4	date	qq/yyyy			♥		♥	♥	♥	♥			
5	place - address	text	♥	♥						♥	♥		
6	address	text	♥	♥					♥	♥	♥		
7	www - url page	text	♥	♥	♥	♥	♥		♥		♥		
8	E-mail	text	♥	♥									
9	categories	classifier	♥	♥	♥	♥	♥		♥			♥	♥
10	role in MENTAL	classifier	♥										
11	annotation	text	♥	♥	♥	♥	♥	♥	♥	♥	♥	♥	♥
12	annotation in English	text	♥	♥	♥	♥	♥	♥	♥	♥	♥	♥	♥
13	picture, scheme	picture	♥	♥			♥			♥	♥	♥	
14	TTD	text					♥						
15	start (date)	dd.mm.yy							♥	♥			♥
16	end (date)	dd.mm.yy							♥	♥			♥
17	evaluation	text	♥	♥			♥	♥		♥		♥	♥
18	problems, risk	text	♥	♥			♥	♥		♥		♥	♥
19	taxonomy domain link	link	♥	♥	♥	♥	♥	♥	♥	♥	♥	♥	♥
20	taxonomy term link	link	♥	♥	♥	♥	♥	♥	♥	♥	♥	♥	♥

Fig. 2 – Attributes of main ontology elements

NEC - UNOB - Windows Internet Explorer  
 http://unob.atom2.cz/form/space.aspx?SpaceId=149  
 Norton | Karty a přihlašovací údaje  
 Oblíbené položky | NEC - UNOB  
 AToM<sup>2.23</sup> | UNOB | NEC  
 Vlastimil Malý

**NEC**

**Classes**

Část organizace	16	Rozvíjí organizační strukturu
Dokument	20	DOKUMENT – informační zdroj (explicitní záznam informace) ve kterém se vyskytuje odkaz, popis, definice na NEC (včetně jiného zdroje).
Etapa	5	Etapa budování NEC AČR nebo NATO NEC, dosahování kvalitativních stupňů.
Obsah dokumentu	56	
Oddíl dokumentu	13	
Organizace	17	Organizace, která má vztah k tématu NEC. Zahrnuje organizační strukturu resortu MO a další prvky ve vztahu k NEC.
Osoba	53	Role osoby, která je ve znalostním systému zaznamenána.
Postup	1	Postup provádění procesů, projektů, činnosti v NEC.
Pravidlo	18	Práva (možnosti) a povinnosti (doporučení) určující provádění procesů nebo průběh událostí ve vztahu k NEC.
Proces	20	Opakovaná činnost v resortu obrany, která téma NEC ovlivní nebo má s NEC nějakou souvislost. Proces má svého vlastníka, je měřitelný, transformuje vstupy na výstupy; platí na něj principy procesního řízení.
Projekt	14	Jednorázová činnost v resortu obrany, která téma NEC ovlivní nebo má s NEC nějakou souvislost. Projekt je časově ohraničený, má svůj cíl, omezené zdroje; platí na něj principy projektového řízení.
Schopnost	11	Schopnost organizační složky armády (nebo celé armády) k plnění stanovených cílů, k realizaci hlavních a řídicích procesů a k dosažení požadavků NEC.
Systém	46	Systém vyjadřuje, ve vztahu na osobu, organizaci, proces a projekt, techniku a výzbroj apod., různé faktické, objektivní role, ve kterých NEC může vzájemně. Systém vykazuje clové chování a je složen z prvků.
Technika a výzbroj	32	Technické a technologické věci, které jsou součástí NEC.
Událost	2	Událost v NEC, kterou je třeba zaznamenat. Je příčinou, důsledkem či cílem procesů a projektů.

Fig. 3 – Part of NEC Ontology in AToM version 2.23

## Conclusion

NEC development is an evolutionary process involving the digitalization of military components, as well as a change of attitude, organization and activities of the MoD and Defence Industry. The Information Management is an enabler for the Information Domain of NNEC. It must support the way we fight and simultaneously shall be based on trust. The Information Age has made it even more important and more difficult. We cannot approach information sharing solely as a network problem, but as a C2 decision-making problem. Adopting a network-centric approach is crucial in the design of all new defence and security systems.

The results of the MENTAL project should promote better understanding of NATO NEC Principles and Information Management, not only in the CIS area, in the Czech Army. Effective solution is provided by the knowledge portal in the NEC area. A very important stage on the way to build this portal (just under development) requires to create the basic ontology of the mentioned domain. This paper describes the current version of NEC ontology on the way ahead.

## Acknowledgement

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