Experiences from applying an Ontology in Hazard Analysis of Autonomous System of Systems

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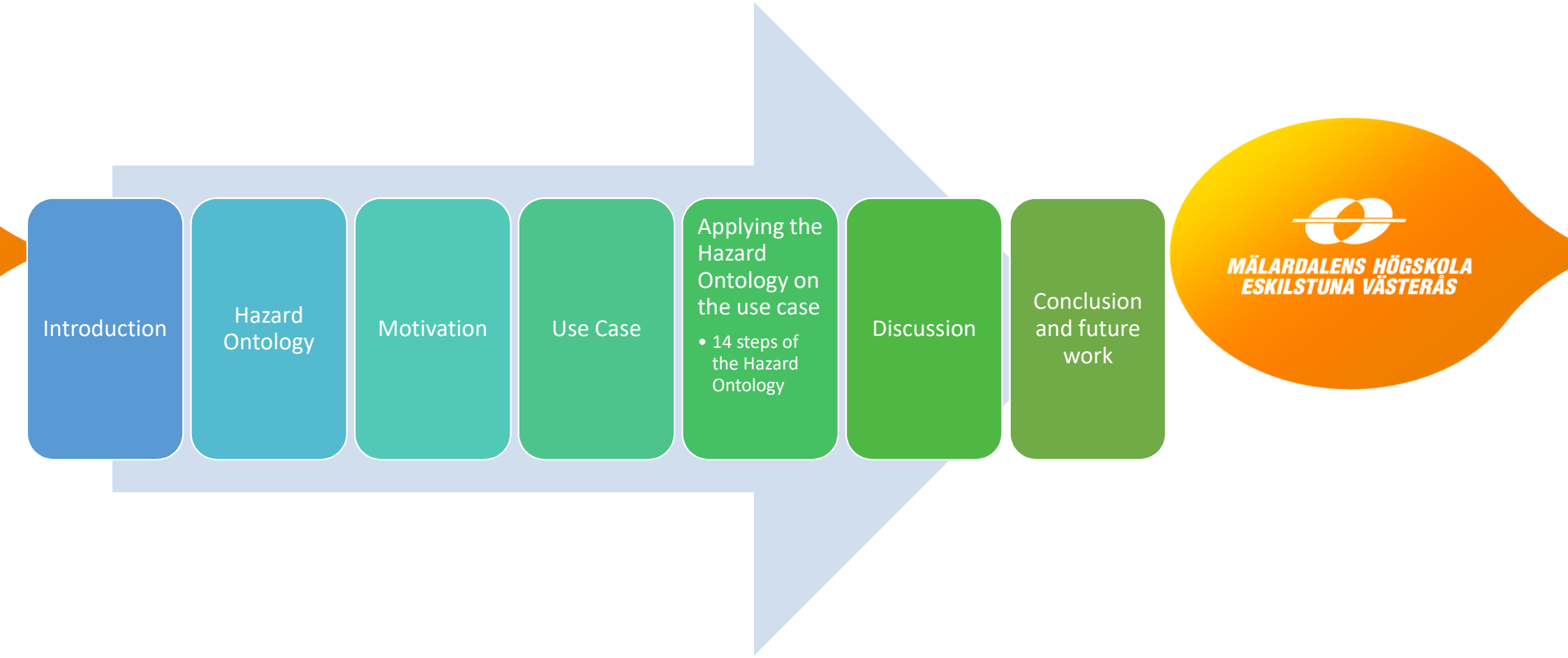
Outline


Introduction
Hazard Ontology
Motivation
Use Case
Applying the Hazard Ontology on the use case
• 14 steps of the Hazard Ontology
Discussion
Conclusion and future work
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Introduction

Ontology provides a formal specification of the terms in the domain and relations among them.

- To share a common understanding of the structure of information among people.
- To make domain assumptions explicit.

Hazard Ontology proposed by Zhou et al. (2017)

is a method of identifying different types of hazards.

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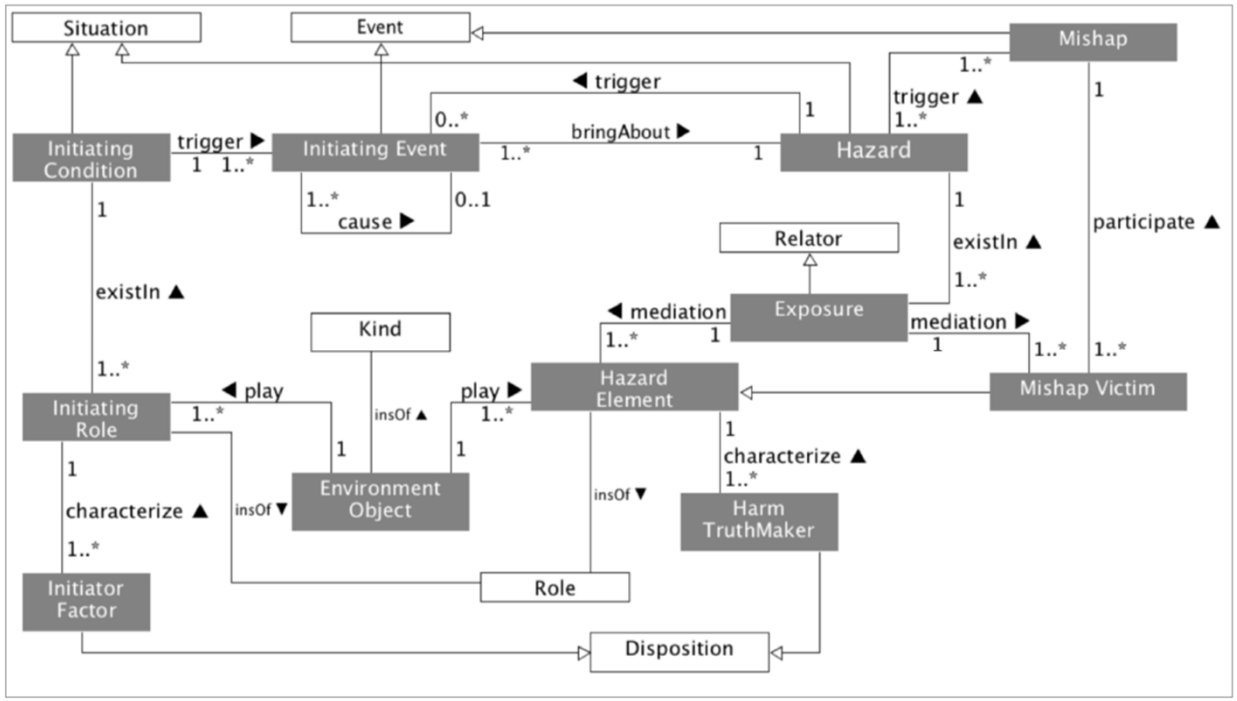
Hazard Ontology



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Motivation

The aim of our work is to present our experiences

during the transformation of a System of Systems description into formal ontological representation

and how to use it for Hazard Identification (HI).

According to ISO/IEC/IEEE 21839 (ISO,2019) *a SoS is set of systems or system elements that interact to provide a unique capability that none of the independent systems can accomplish on its own.*

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Use case

The Use Case is a quarry consisting of Autonomous Vehicles (AV), operators and other equipment.

The goal of the system is to collaborate in aggregate production process.

The plant is in production mode (operational mode).

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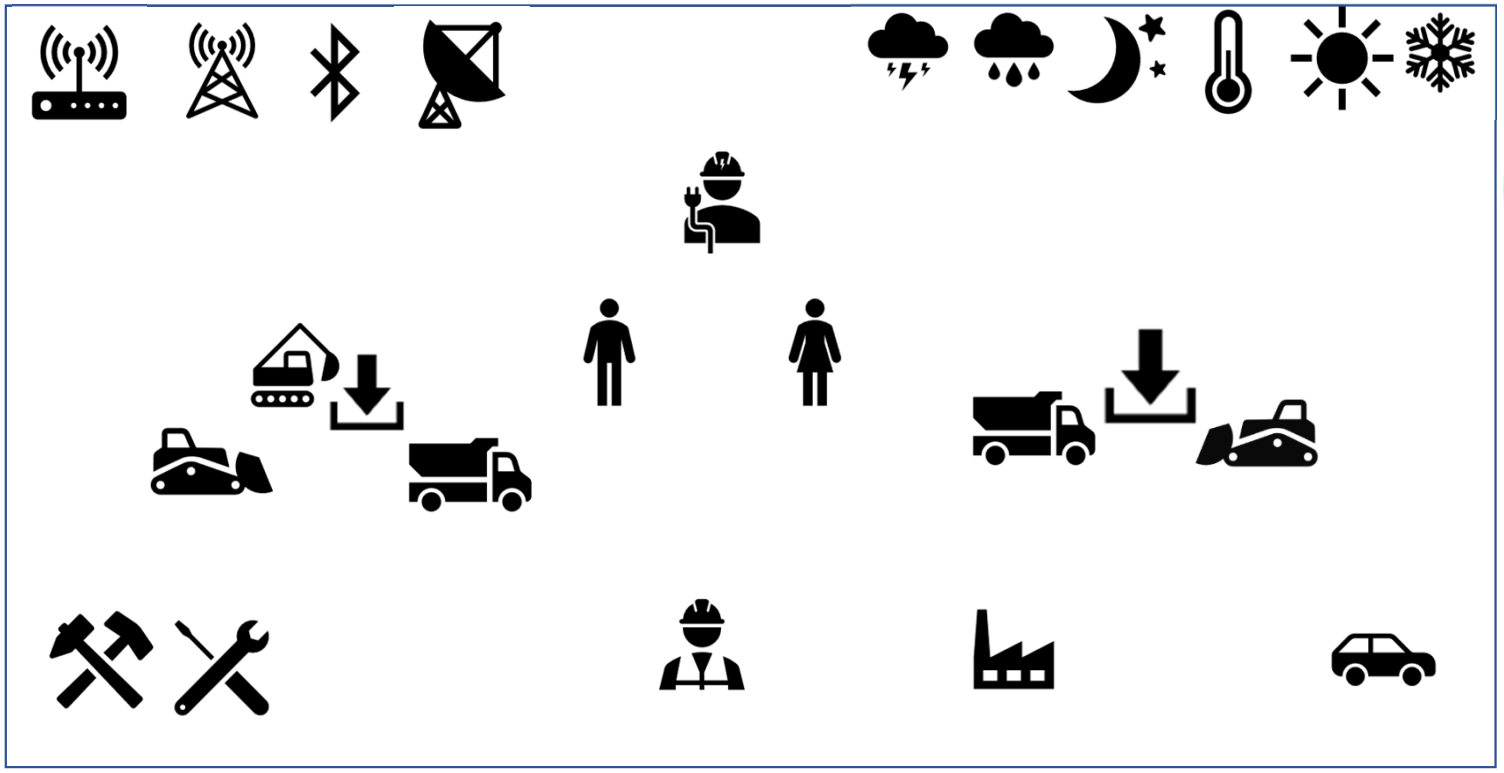
Use case



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I will not tell a story but… Let's play together a game

Do you remember Hopscotch?

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Source: http://www.retroland.com/hopscotch/

Applying the Hazard Ontology on the use case – 14 steps

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1.1. IDENTIFYING KIND OBJECTS

1.2. IDENTIFYING ROLES

1.3. IDENTIFYING RELATORS

1.4. IDENTIFYING KIND OBJECTS PLAYING ROLES

Applying the Hazard Ontology on the use case – 14 steps

1.5. IDENTIFYING MISHAP VICTIMS

1.6. IDENTIFYING ENVIRONMENTAL OBJECTS PLAYING MISHAP VICTIMS

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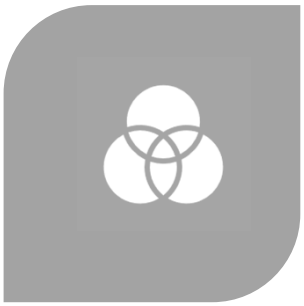
1.7. IDENTIFYING RELATORS CONNECTING ENVIRONMENTAL OBJECTS WITH ROLES



1.8. IDENTIFYING DISPOSITIONS CHARACTERIZING ROLES

1.9. ASSIGNING HAZARD ELEMENTS, HARM TRUTHMAKERS, AND EXPOSURES

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1.10. IDENTIFYING INITIATING ROLES

1.11. IDENTIFYING INITIATING FACTORS

1.12. IDENTIFYING INITIATING CONDITIONS

1.13. IDENTIFYING INITIATING EVENTS

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Applying the Hazard Ontology on the use case – 14 steps

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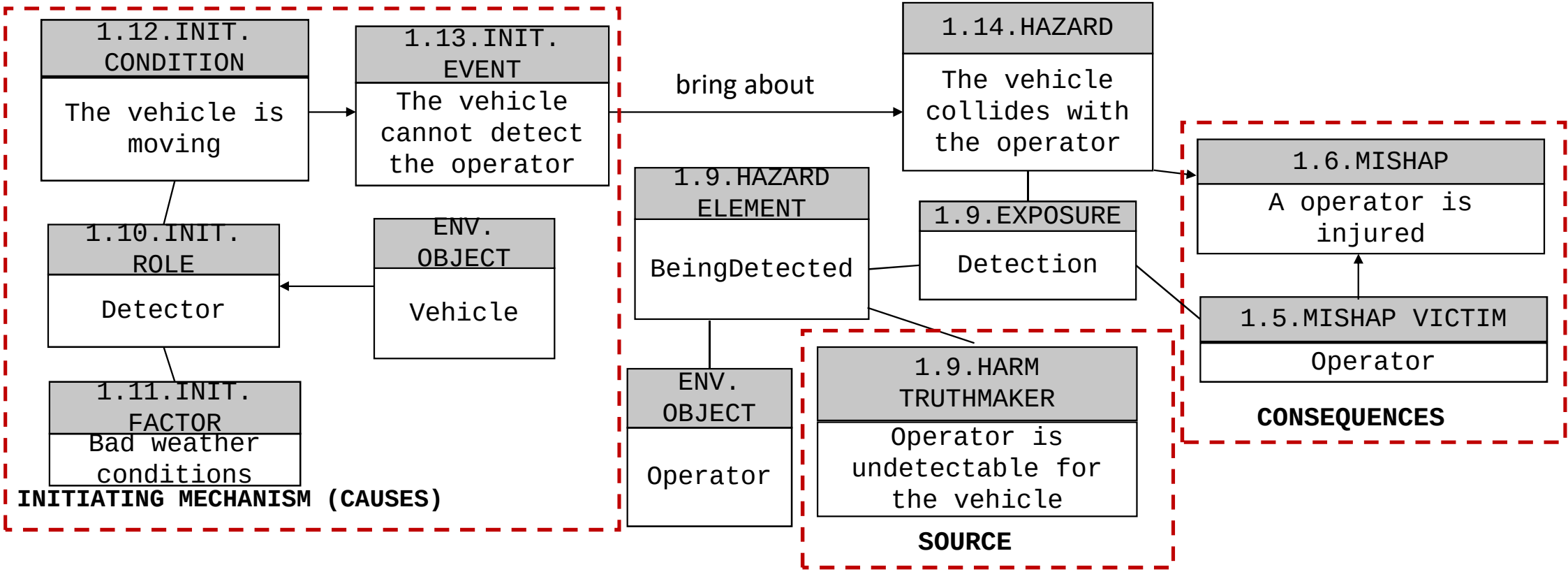
1.14. DERIVING HAZARDS
AND MISHAPS

The complete Ontology



Discussion

We can emphasize that we could perform the HO

in the autonomous SoS without enough information because we studied the necessary document and articles.

This approach can be used by a non-experienced person.

SoS still evolves and the HO will evolve with it.

It means that HO will be extended with new elements and new relations.

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Conclusion and Further work

Contributions

Conclusions obtained from experiences and problems encountered during the transformation of the description of the natural language system into an ontological representation for Hazard Identification (HI).

Findings regarding HI and hazard's elements, including relations between them.

Initial results show that the systematic way defined by ontologies allows for detailed analysis of potential interactions between systems and could facilitate identification of emergent hazards.

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Future work

The proposed method can be improved by developing a tool that allows to gather, identify and analyze various types of hazards in an autonomous SoS.

Thank you for your attention!

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