Members of AI4SysSoS/ICONS 2021

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- Hany Fawzy graduated from Electronics and Telecommunication Department, Faculty of Engineering, Cairo University in 1985
- He obtained his Ph.D. degree from University of Nancy 1 (Lorraine University) in Artificial Intelligence in 1992.
- Dr. Fawzy continued his research in the domain of AI application in different fields such as telecommunications and health systems.
- In 2005, Dr. Fawzy joined the Canadian Department of Defense as a Systems Engineer and participated in managing the System of Systems engineering cycle of the intelligent Land Command Support System.
- In 2011, Dr. Fawzy joined the Canadian Space Agency (CSA) as a Senior Systems Engineer, he worked as Lead Systems Engineer for RadarSat Constellation Mission Ground Segment. Currently he's a member of CSA Lunar Gateway Program Systems Engineering Team. In his function, he supports the different Artificial Intelligence activities within the gateway program as well other CSA AI scientific and industrial initiatives.

Extending System Engineering Methodology into the Era of Artificial Intelligence

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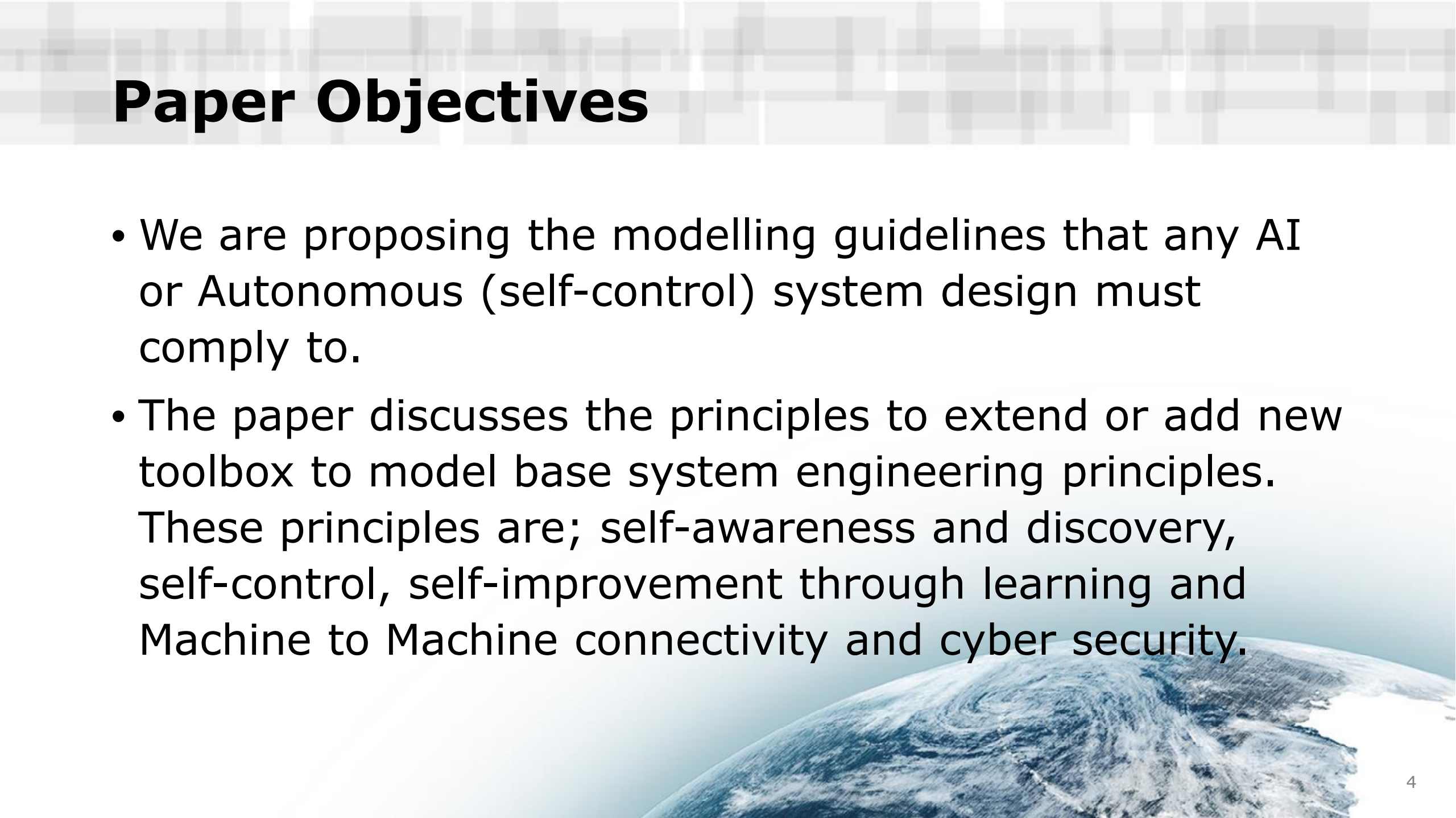
Introduction

- Artificial Intelligence (AI) will force all stakeholders to re-examine their traditional methods for designing and engineering of all future intelligent and autonomous systems.
- AI proposed definition: The capacity to emulate and simulate human intelligence operating a machine using learning, reasoning and interacting with a dynamic world environment.

Paper Objectives

- We are proposing the modelling guidelines that any AI or Autonomous (self-control) system design must comply to.
- The paper discusses the principles to extend or add new toolbox to model base system engineering principles. These principles are; self-awareness and discovery, self-control, self-improvement through learning and Machine to Machine connectivity and cyber security.



Principles

- Self Awareness
  - to *recognize and understand the dynamic world model interactions with the system*.
- Dynamic world modelling
  - A world model, in our study, *must be able to discover and introduce new elements when necessary to the world it represents*.

Principles

- System of Systems Modelling
  - Such principle would allow the model *growth*. It also supports the understanding of the *dynamic behavior* especially in complex systems.
- Machine-to-Machine Communication
  - It will support the definition of required input to the model, how much the input *trustworthy* and whether it *comes from a machine or not (discovery)*.

Principles

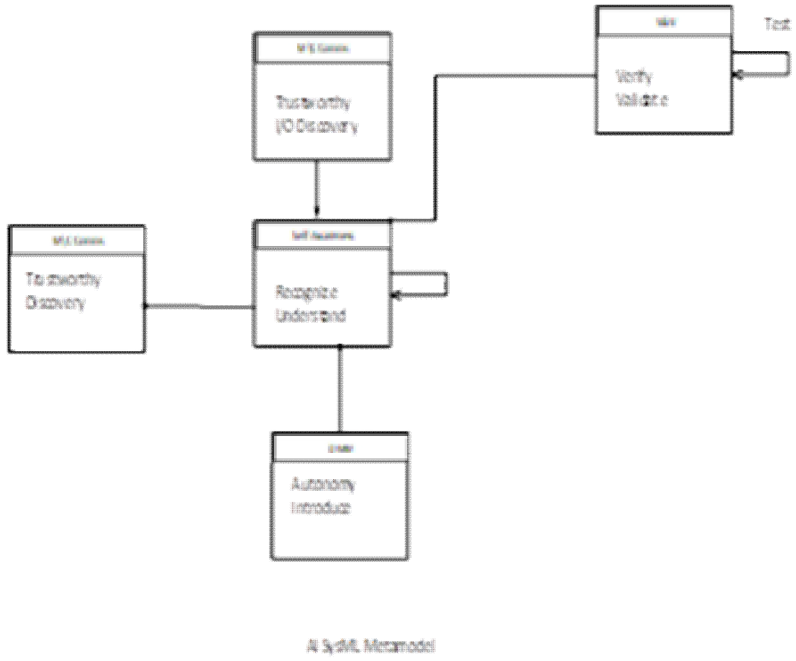
- Self-improvement Through Learning
  - *Training and retraining* of the engineering systems is important.
- Autonomy (Self-control, and could be Self-sufficient)
  - It would support the definition and the capacity of the system to *trust its output, control its inputs and outputs, request of support*
- Trust and Data Sets
  - We will need to handle *data and metadata configuration management*.
- Verification and Validation
  - There must be a capacity to model V&V of the system.

Planning

- It is important to plan for AI applications in an organization.
- Planning for AI and Autonomy:
  - Autonomy and AI Strategy for the program;
  - Application Area Identification;
  - Planning;
  - Implementation;
  - Technology aspects; and
  - What is next.
- It is important that the System Engineering Approach be able to model the AI and Autonomy applications.

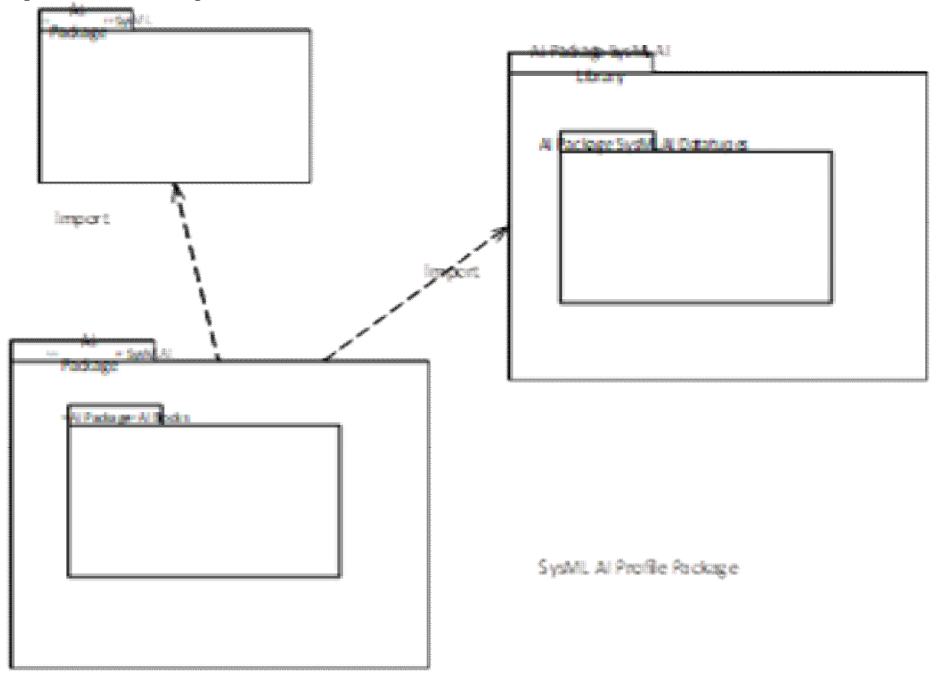
Implementation

- Figure 1 shows the proposed domain model defined as a meta-model.



AI SysML Metamodel

- Figure 2 offers a high-level view of the organization of the SysML profile.



SysML AI Profile Package

Conclusion and Future work

- Future work:
  - Create principles for:
    - Cyber Security;
    - Learning and Big Data;
    - Human role and Bias; and
    - Standardization/Certification.
- We presented a set of principles that would allow the current System Engineering approach based on MBSE to model AI and autonomous systems. In fact, we extended the modelling of AI and autonomous systems to include SoS aspects.