european Robotics Forum 2016

Robot Ontology Standards

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⊙ Introduction

Óbuda University

Antal Bejczy Center for Intelligent Robotics

Collecting and organizing OU robotics

- Established based on applied research
- Focusing on human-centered studies
- Building on intl. relations – leaders of CELLI
- Setting up cloud robotics, as service
- Focusing on service, social and medical applications

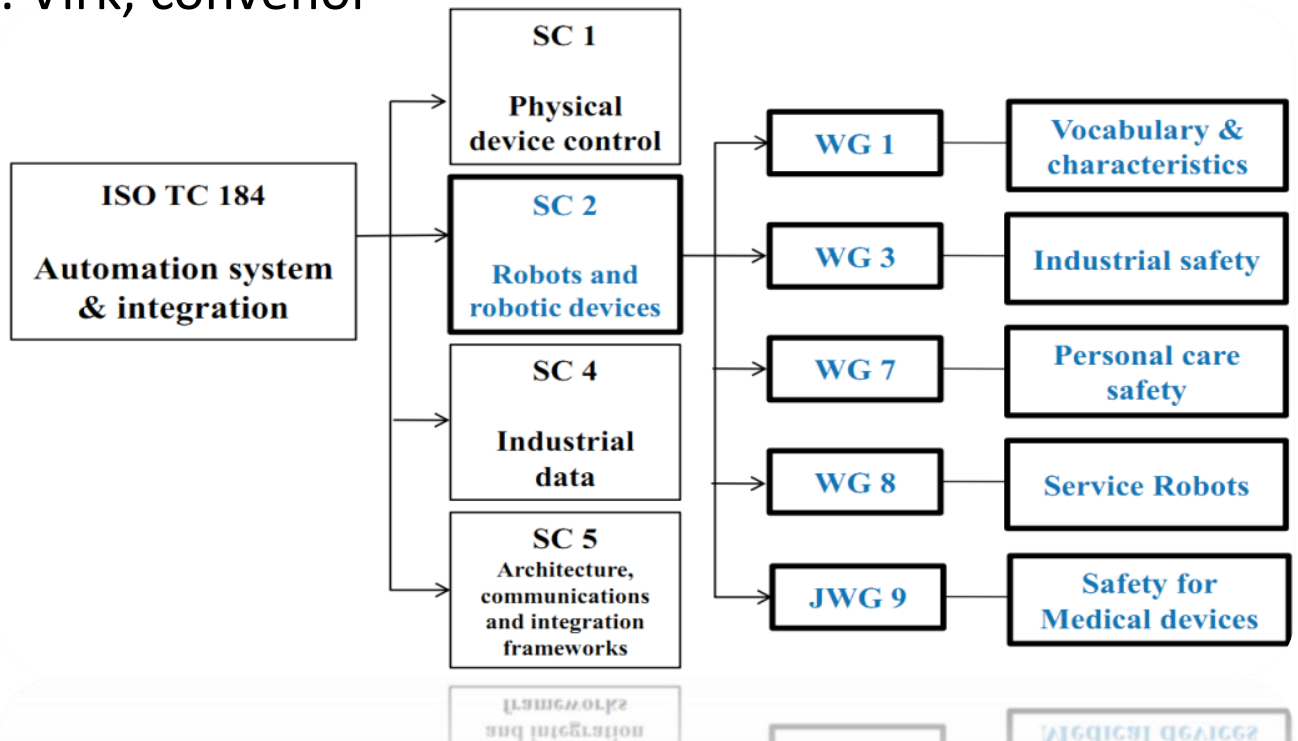
⊙ Involvment

Developing standards & ontologies

International Organization for Standardization

ISO/TC 299/JWG 9, JWG35 (IEC 62D)

- TC 299: Technical Comm. on Robots and robotic devices
- **JWG 9: Joint Work Group on Standard for Medical Robot Safety**
  - G. Virk, convenor



⊙ Defining Robots

"- Robot: *actuated mechanism programmable ~~in two or more axes~~ with a degree of autonomy, moving within its environment, to perform intended tasks.*"
- Service robot: *Robot that performs useful tasks for humans or equipment excluding industrial automation applications.*
- Medical robot: *A robot with medical intended use.*"

ISO 8373:2015

"A robot is a mechanical or virtual agent, usually an electro-mechanical machine that is guided by a computer program or electronic circuitry."

Wikipedia

"I can't define a robot, but I know one when I see one."

/J. Engelberger/

Classical approach challenged by human-centered systems

⊙ Robots and robotic systems

Industrial robots

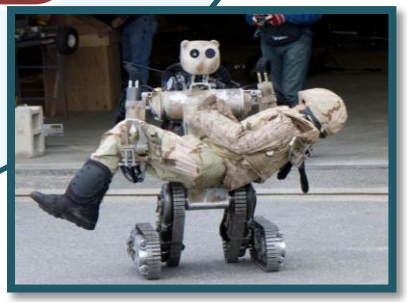
- Fixed base
- Mobile

Service robots

- Personal
- Professional

Other applications

- Military



Robotic systems in accordance with **ISO 8373**, based on **applications**

⊙ Defining ontologies

- *Vocabulary + Structure = Taxonomy*
- *Taxonomy + (Relationships and Constraints) = Ontology*

/C. Schlenoff/

"Ontologies can be viewed as content theories that focus on properties and relationships among objects from a specific domain"

/B. Chandrasekaran et al./

Ontologies explicitly represent key concepts, their properties, their relationships, and their rules and constraints.

Ontology is a tuple <S, A>, where S is the vocabulary (or signature) of the ontology and A is the set of ontological axioms specifying the intended domain vocabulary.

/Kalfoglou&Schorlemmer/

Ontologies believed to allow knowledge transfer – as human–robot interfaces

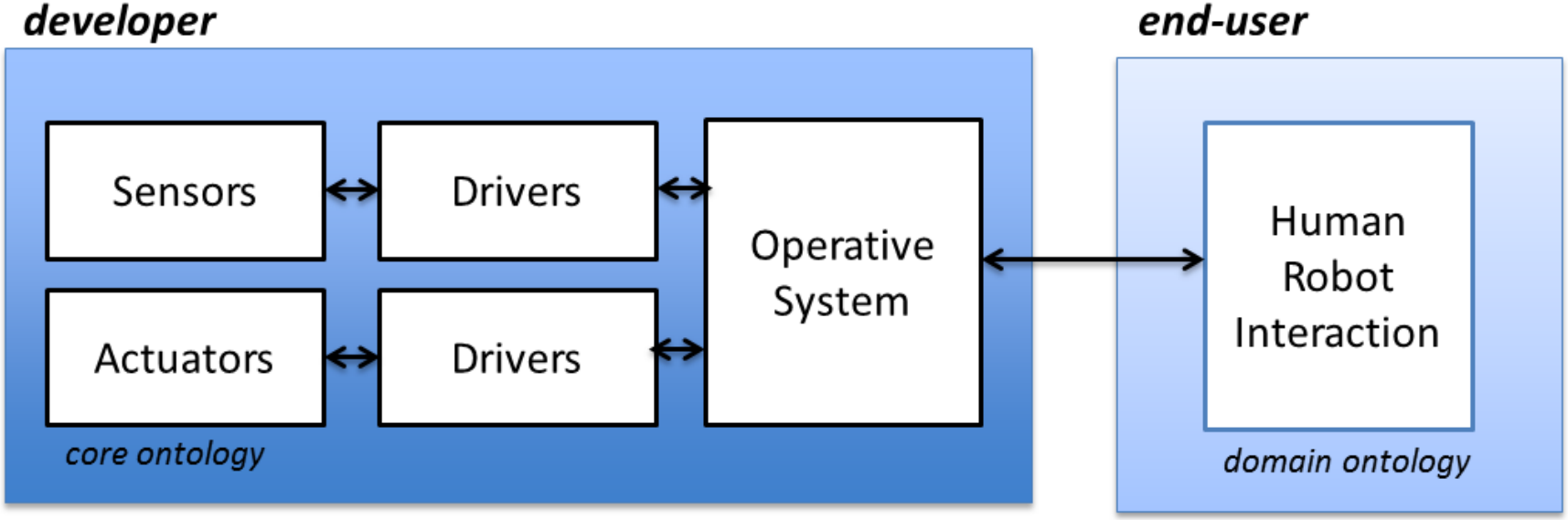
⊙ IEEE RAS JWG

IEEE Ontologies for Robotics and Automation Working Group (ORA WG)

50+ members from 20 countries

CHAIRS: Craig Schlenoff (US), Edson Prestes (BR)

AIM: To develop a standard ontology and associated methodology for knowledge representation and reasoning in robotics and automation, together with the representation of concepts in an initial set of application domains.



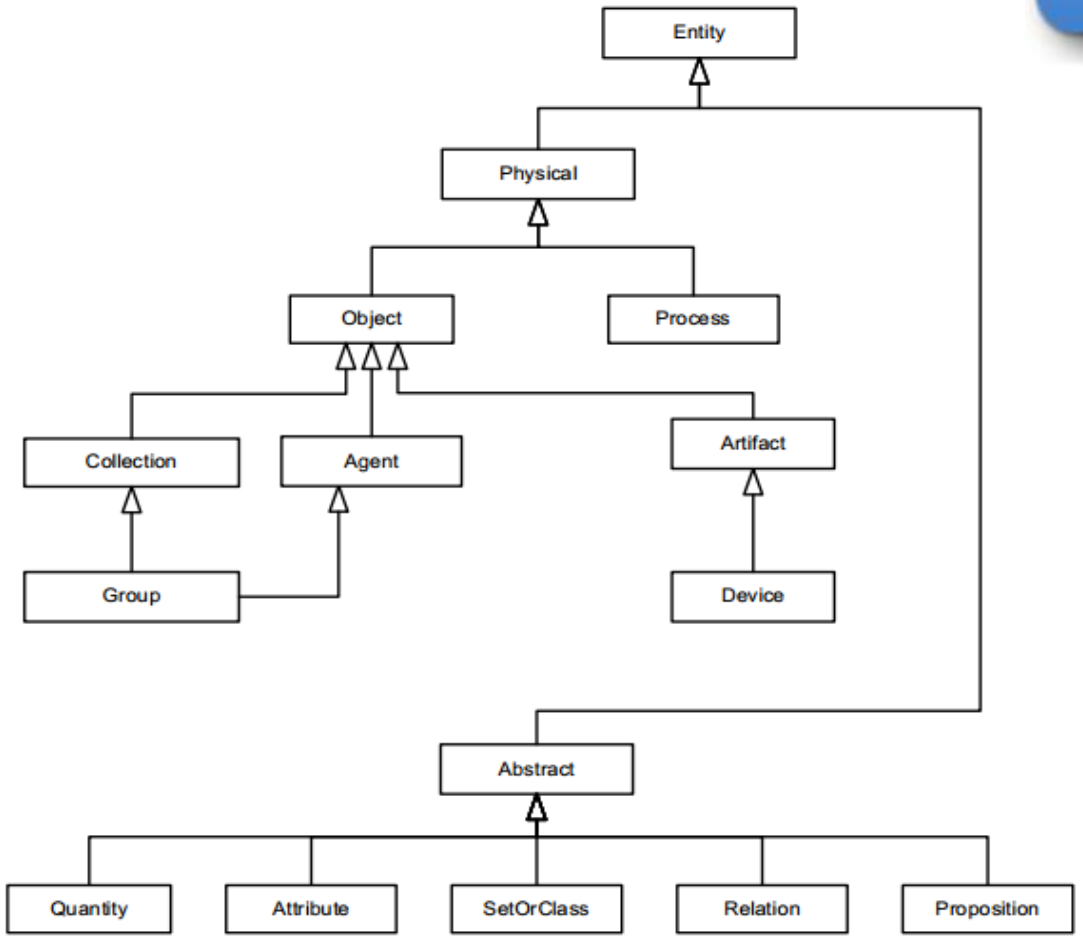
⊙ Ontologies for robots

- **Core ontology of robotics**

+ **https://standards.ieee.org/findstds/standard/1872-2015.html**

"A core ontology that specifies the main, most general concepts, relations, and axioms of robotics and automation (R&A) is defined in this standard, which is intended as a reference for knowledge representation and reasoning in robots, as well as a formal reference vocabulary for communicating knowledge about R&A between robots and humans. This standard is composed of a core ontology about R&A, called CORA, together with other ontologies that give support to CORA."

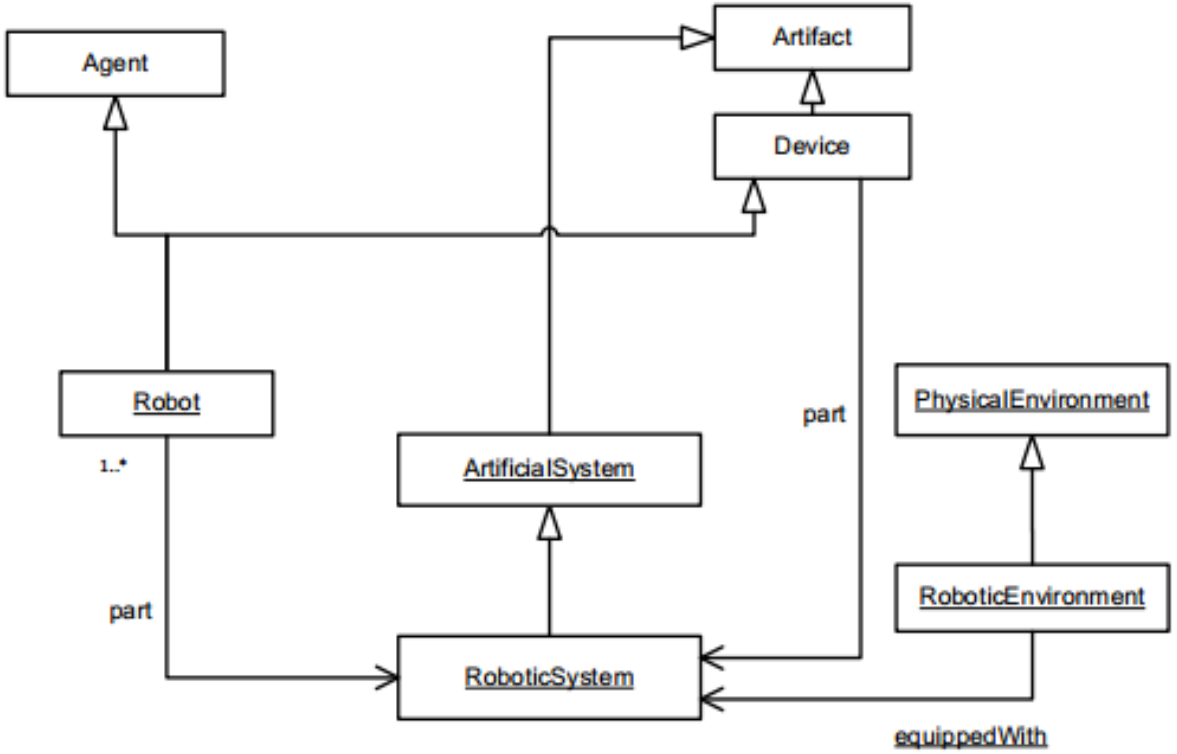
⊙ Ontologies for robots



- **Following the general SUMO taxonomy**

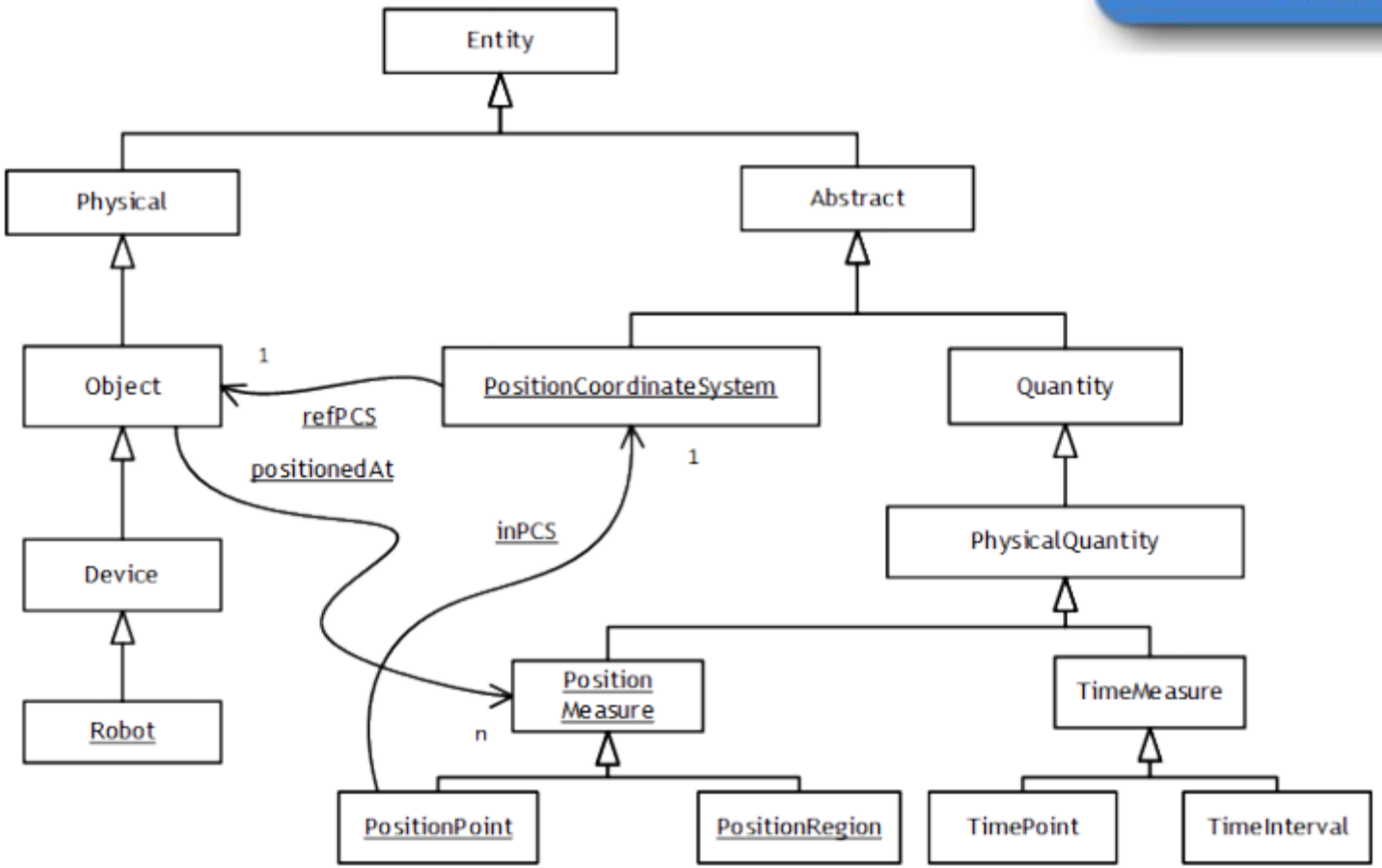
http://www.adampease.org/OP/

⊙ Ontologies for robots



Robotic system and its relations with robot and robotic environment

⊙ Ontologies for robots

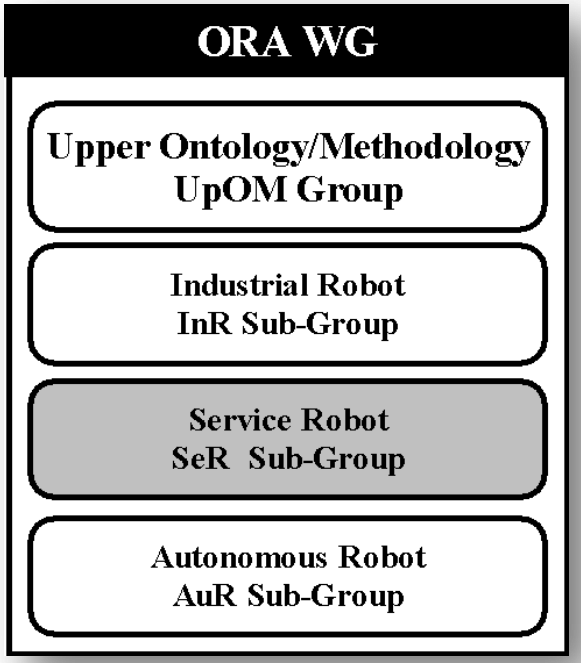


Main concepts in POS ontology regarding Position

⊙ Ontologies for robots

- **Sub-domain ontologies**
  - **Working group activities**

❖ **Industrial robot ontology** (S. Balakirsky et al. , Implementation of an Ontology for Industrial Robotics; IROS2014)
❖ **Service robot ontology**
❖ **Autonomous robot ontology**
❖ **Space robot ontology**
❖ **Medical robot ontology**



⊙ Building an ontology

Proposed construction strategy

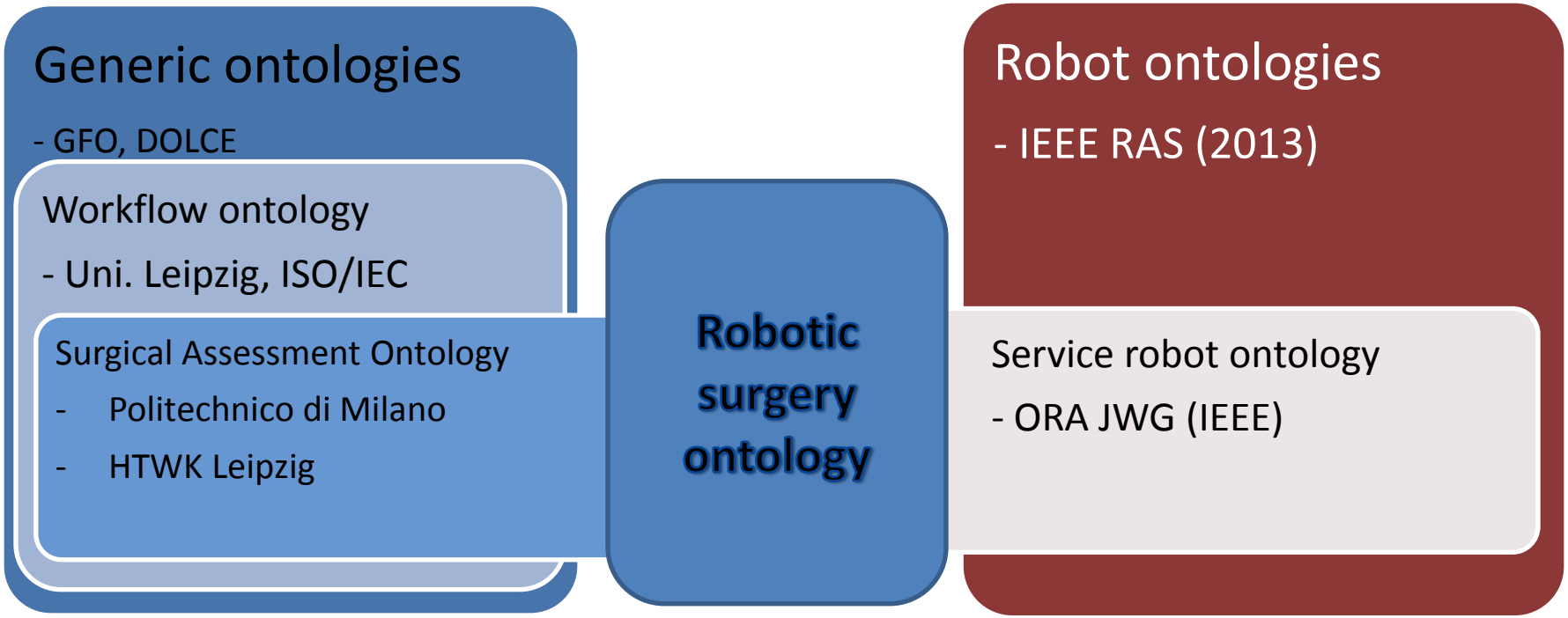
- **Life cycle proposal:** choosing one approach
  - E.g., ontology development process based on IEEE 1075-1995 Standard for Software Development Process
  - IEEE 1074-1997 IEEE Standard for Developing Software Life Cycle Processes
- **Strategy with respect to the specialty of the application domain**: taking into consideration the interdisciplinary domain requirements
- **Relying on the core ontology:** identifying the interfaces and respecting the P1872
- **Choose strategy to identify concepts**
  - from the most concrete to the most abstract (bottom-up)
  - from the most abstract to the most concrete (top-down)
  - from the most relevant to the most abstract and most concrete (middle-out)

⊙ Ontologies for medical robots

- **REHABROBO-ONTO (Sabanci University)**
- **Surgical Workflow ontology (SWOnt)**
- **SOCAS ontological concepts (Leipzig University)**
- **European Robotic Surgery FP7 project**
  - www.eurosurge.eu
  - Laboratory for Teleoperation and Autonomous Intelligent Robots (ALTAIR), University of Verona
  - Ontology Web Language (OWL)
  - Protégé (3.4.6:2011)

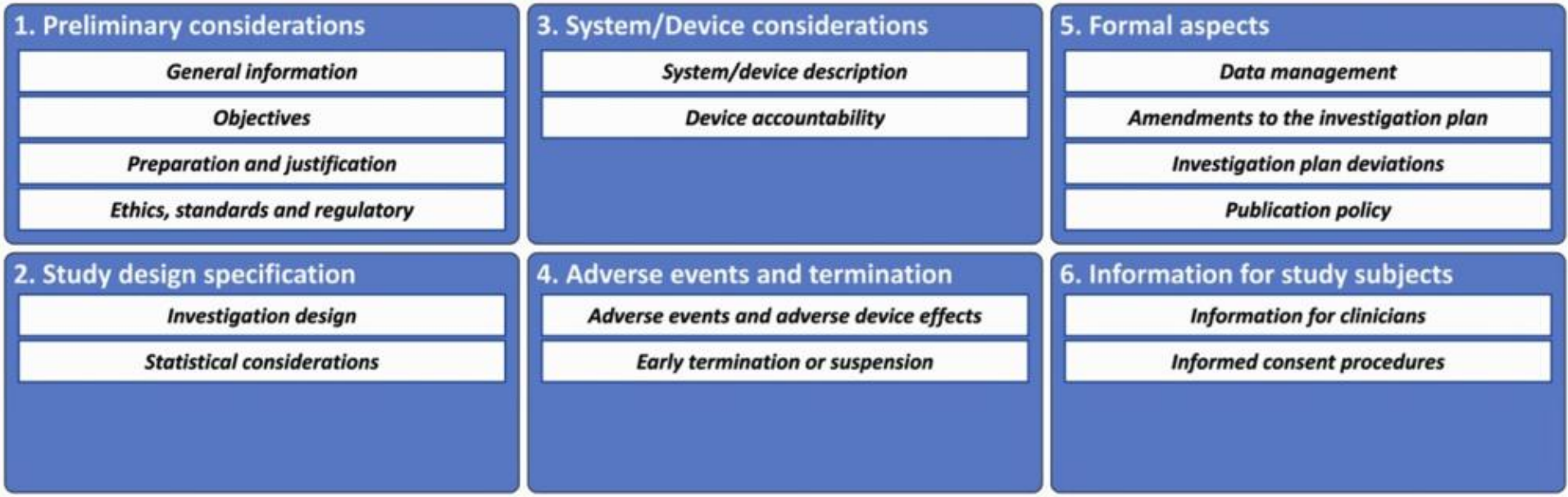
⊙ Developing ontology

- **Exploiting state-of-the art ontologies**
  - A. Machno, W. Korb t al.: "*Ontology for Assessment Studies of Man-Computer Interaction in Surgery*". Artificial Intelligence in Medicine, *to appear,* 2013
  - T. Haidegger, M. Barreto, et al. *"Applied Ontologies and Standards for Service Robots"*, Robotics and Autonomous Systems, vol.61, no.11, pp.1215-1223, 2013



⊙ System built on methodology

- **Integrate already developed standard components**
  - ISO 14155: Clinical investigation of medical devices for human subjects
    Good clinical practice
  - ISO 13485, ISO 14971, IEC 60601-1



Jannin P, Korb W (2008). **Assessment of Image-Guided Interventions**. In: Peters T M and Cleary K Image-Guided Intervention Principles and Applications. Springer, pp.531-549.

⊙ Benefits of ontologies as standards

- Standardized knowledge representation
- Common measures and definitions in R&A
- Measurability and comparability of R&A technology
- Integratable, portable and reusable knowledge

Future work:

- Ontologies for decision support
- Ontologies for risk management
- Identifying essential performance and safety

http://ieee-ras.org

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