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Anticipating health hazards through an ontology-based, IoT domotic environment

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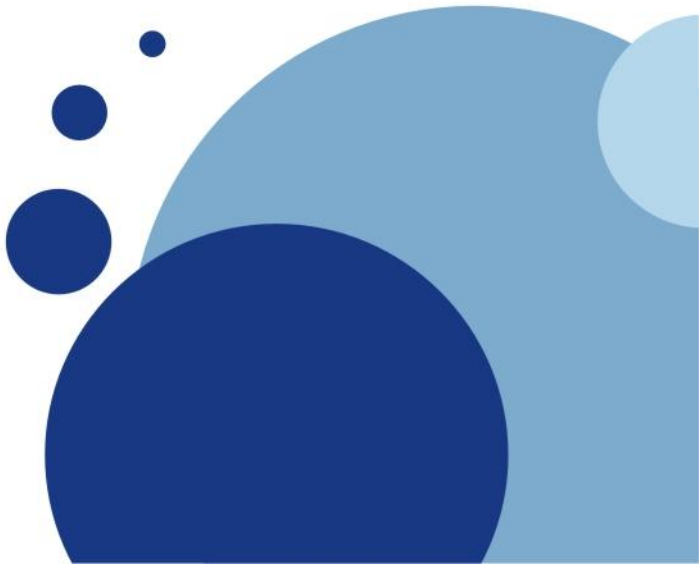

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Domotics Lab

Research Lab of the "Institute of Science and Technology of Information" (ISTI) of the National Research Council of Italy (CNR).

Domotics Lab aims to improve the quality of everyday life contributing to achieve the *Ambient Intelligence* (AmI) and *Internet of Things* (IoT) visions.

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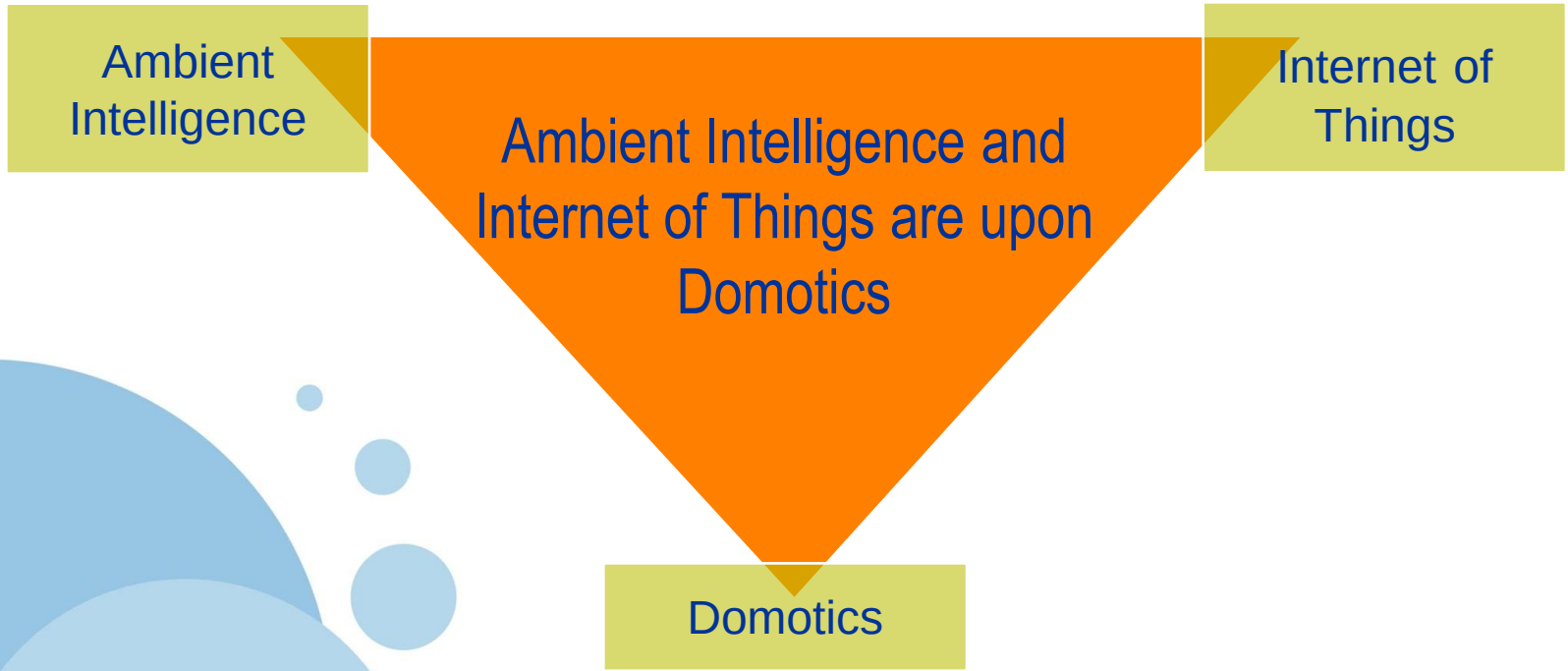
Our mission



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What domotics is

It is a set of multidisciplinary technological based solutions that aim to:

- Comfort
- Energy saving
- Safety
- Disabled and elderly people (more safety means more autonomy)
- Remote control
- Entertainment
- Access to external service
- Integration of all electrical, gas and water equipment to create smart applications…

but...

the lack of an unique standard and the poor integration among different technologies (interoperability issue)

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The goal

Thanks to:

- Miniaturization of electronic components → higher integration of technology on our everyday life
- Internet of Things → hidden distributed technology on everyday objects

Goal to reach:

Users must adapt themselves to the environment and to the technologies.

The technologies and the environment must be hidden and adapted to real user needs.

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Ambient Intelligence

Our guidelines aim to realize an intelligent ambient where people can live surrounded by information and telematic technologies. The environment must be:

- **embedded**: integrated in the environment (user hidden technology);
- **interoperable**: all devices must be able to communicate each others indipendently by their communication and technology standards;
- **context aware**: able to recognize users and their ambient context;
- **personalized**: customized to user needs;
- **adaptive**: able to change in depending on new scenarios;
- **anticipatory**: able to anticipate the needs and the wishes of users in a unaware way for them.

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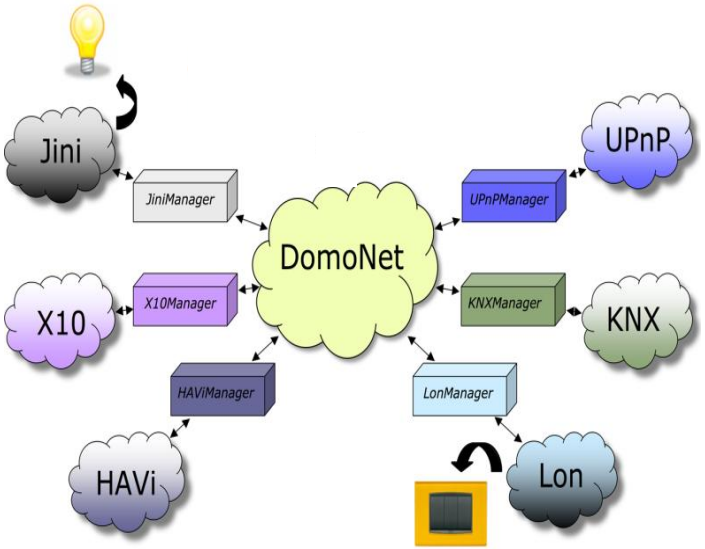
Interoperability: DomoNet



- Existing framework developed by our Lab
- Based on SOA and XML-complaint language approaches
- It is able to abstracts heterogeneous domotic systems to describe functionalities, datatypes, messages and interaction models
- DomoML: "Lingua franca" to enable the interoperability solution

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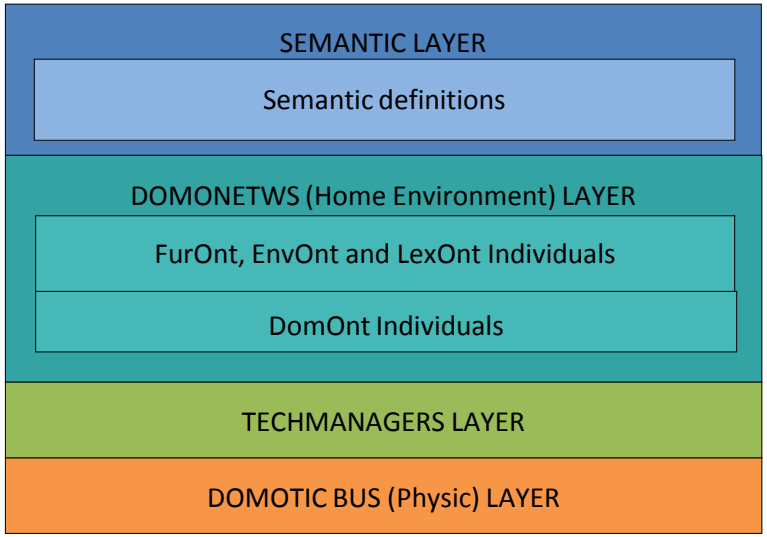
Innovative ontology approach



With the introduction of semantics it is possible to:

- contextualize the environment, give a meaning to devices, furnitures and places, and exploit ontology reasoner features;
- define the goal to reach and the the system autonomously will be able to know the actions to perform (e.g. "have more light in living room" can turn on a lamp or open the blinds);
- abstract domotic devices and technologies using a more powerful and intelligent way to realize interoperability

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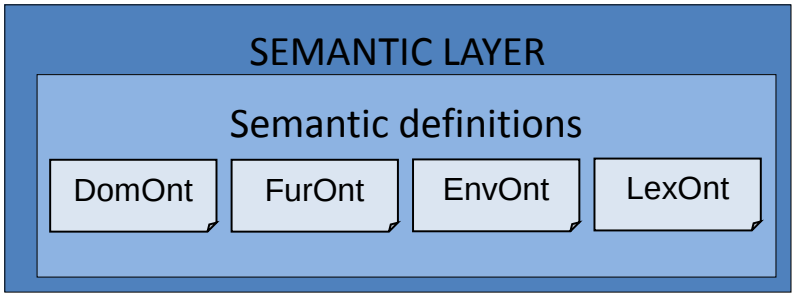
Innovative semantic approach (1/2)



Semantic layer upon DomoNet:

- *DomOnt* (Domotic Ontology): includes an integrated taxonomy of domotic devices and their functionalities.
- *FurOnt* (Furniture Ontology): defines objects such as tables, chairs, mirrors and so on.
- *EnvOnt* (Environment Ontology): specifies where devices and furniture can be positioned. It defines the meaning of different rooms, such as "bathroom", "kitchen" or "bedroom". It includes *relations* such as "contains bed", "the place for eating", etc.
- *LexOnt* (Lexical Ontology): indicate the positions of objects and devices inside the environment and their inter-relations ("near", "on", "under" and so on.)

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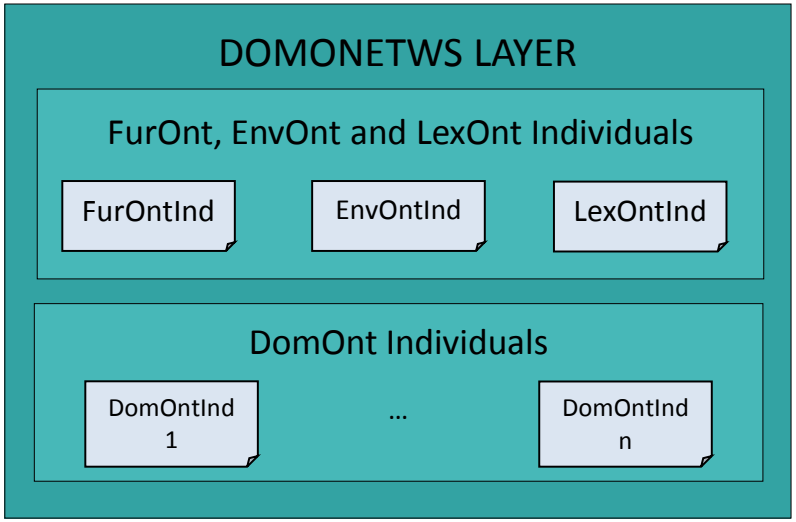
Innovative semantic approach (2/2)



Contextualization of abstracted devices using system ontologies

Implementation of interoperability feature:

for each domotic technology there is an ontology able to map real devices and their interactions inside the system in order to create an unique and indipendent technology view.

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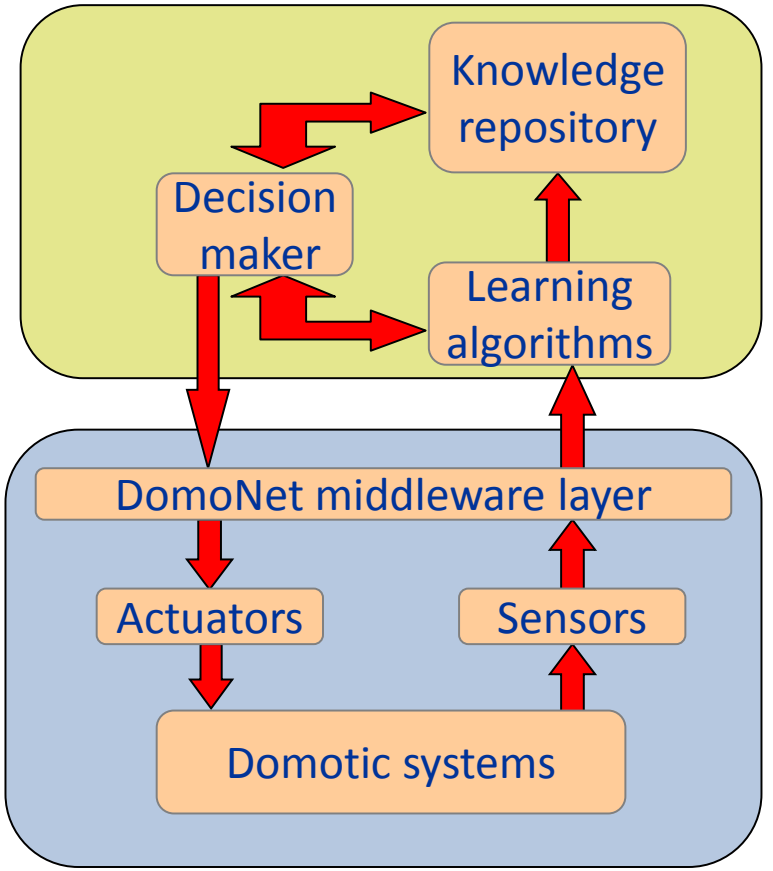
Our Ambient Intelligence solution

- Open source prototype developed by our laboratory
- Learns user habits → predict user needs and take notice of unusual behaviors
- Use of W3C open source tools and standard (Web Services, XML)
- It belongs and exploits the DomoNet architecture features
- Agent programmed rules approach (against pre-programmed and user-programmed rules)
- Reinforcement function



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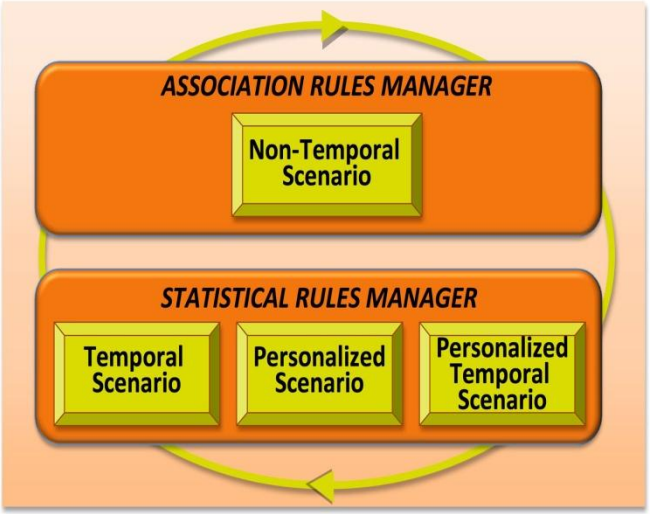
Innovative DomoPredict approach



Innovative hybrid approach: *association rules manager* with *Apriori algorithm* and *statistical rules manager*: they identify sequences of events within a prefixed temporal window size (scenario):

- **Non temporal scenario**: represented by a set of actions usually carried out by the user, but unrelated to time;
- **Temporal scenario**: is made up of one or more actions usually executed at the same time of the day or for a long period of time;
- **Personalized scenarios**: is a set of actions that permits the system to configure the user environment using his personal preferences;
- **Personalized temporal scenario**: learns the user's preferences along a time scale by analyzing the state of the system at precise moments during a fixed period.

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Fields of application

Comfort: anticipating user needs automating the activation of scenarios.

Health: anticipating user needs and recognizing unusual and dangerous behavior of sick persons, elderly or disabled people without the use of medical devices but only using environmental sensors.

Example: for user with heart trouble, the system checks:

- changing of habits as going to bathroom and coughing during night;
- behavior changes in relation to a rest after an physical effort
- creation or alteration of scenarios including critical situations.

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Conclusions

DomoPredict framework permits to anticipate unusual and dangerous users behaviours to recognize changes of both user habits and needs.

Through *DomoNet* framework, *DomoPredict* is able to interact with domotic systems through a semantic way, and so, in "*intelligent way*" with the environment.

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Future works

Creation of a friendly human machine interface based on natural language to interact with the system

Integration to the system of external medical ontologies and medical devices in order to work for the improvement of the ability to the disease prediction

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