

Systemes Collectifs Adaptatifs et Systemes Multi-Agents

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Partie 4 – SMA and Ambient intelligence system

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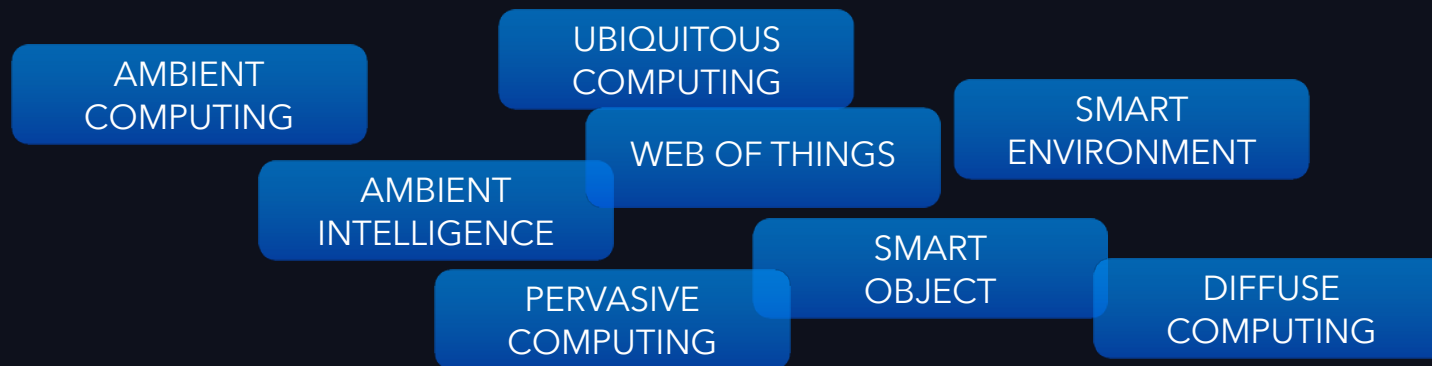


Systèmes Collectifs Adaptatifs et Systèmes Multi-Agents

Sommaire

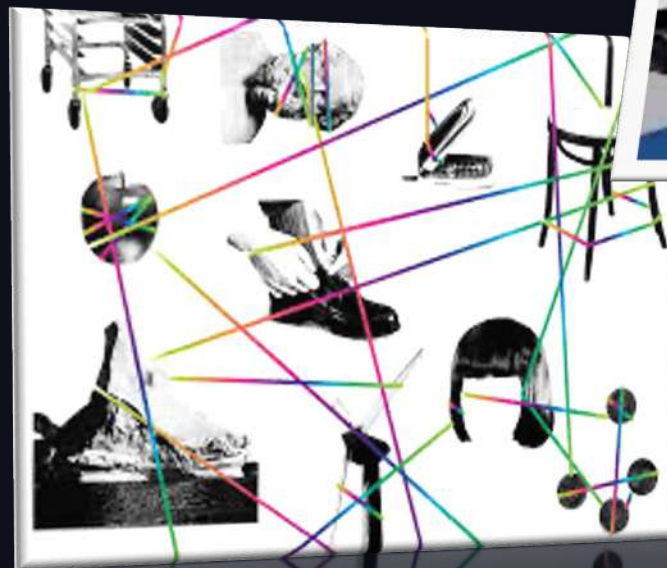
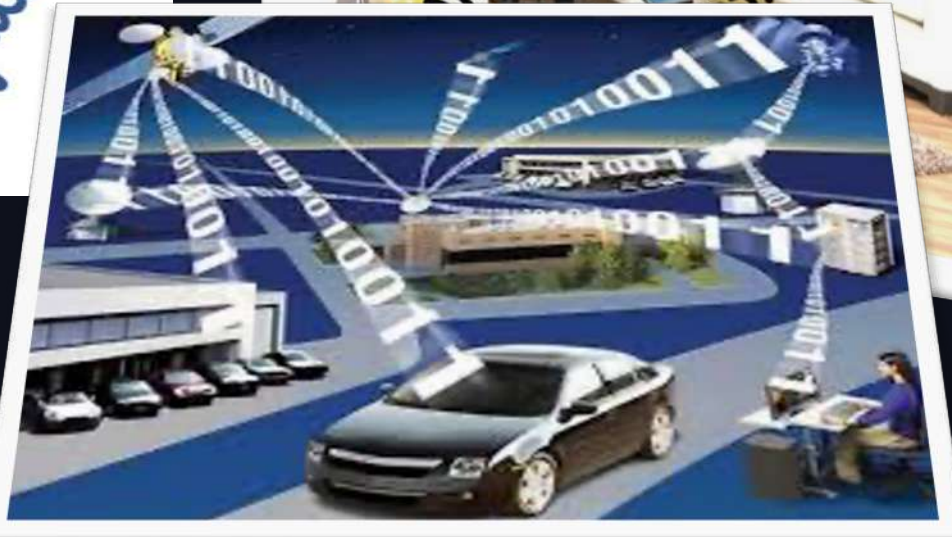
Partie 3 : SMA and Ambient intelligence system

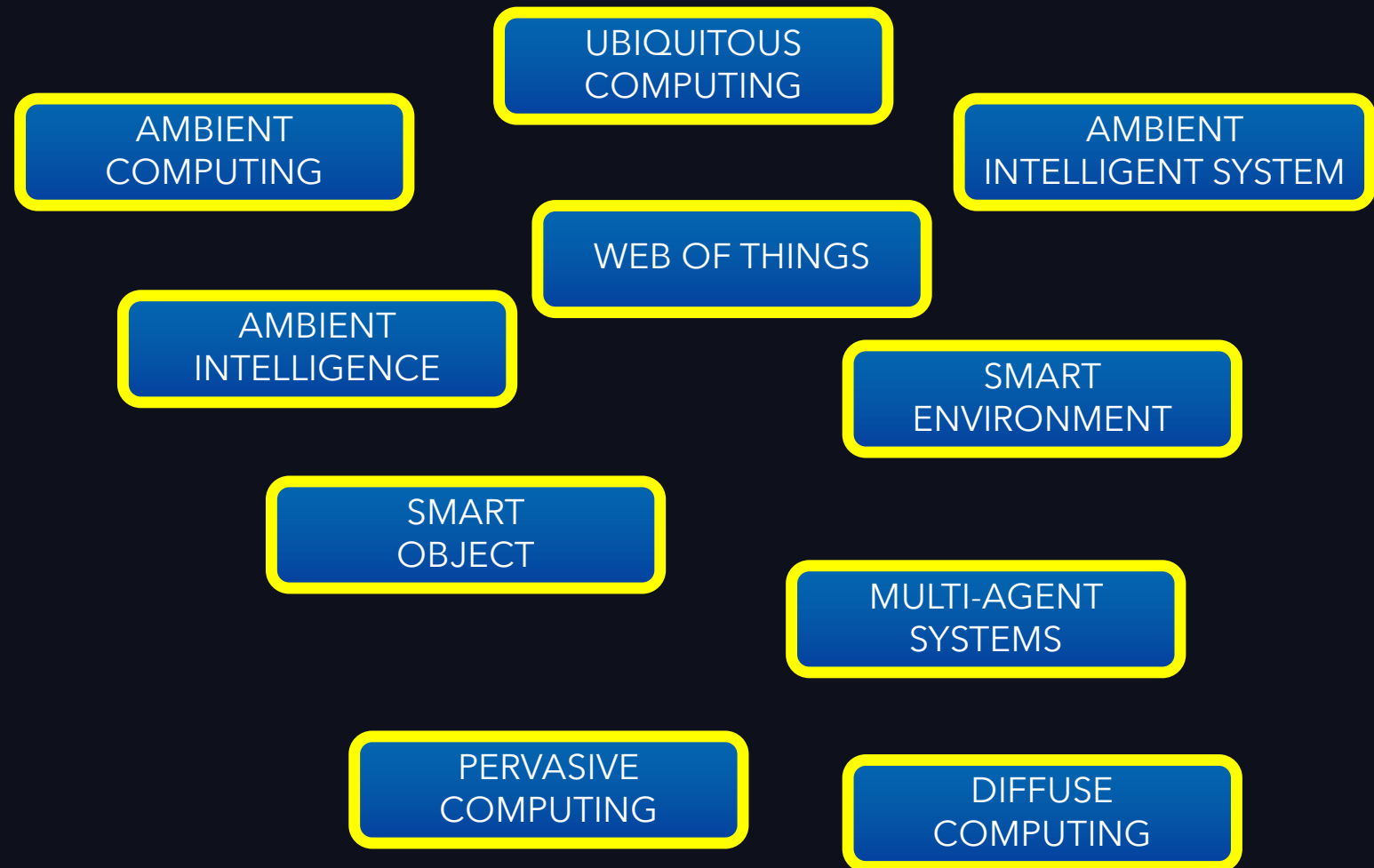
- Definitions and Links Between Fundamental Notions



- Toward a Link Between SMA and Ambient Intelligence







**UBIQUITOUS
COMPUTING**

The terms **ubiquitous computing**, **pervasive computing** and **diffuse computing** are equivalent.

AMBIENT
COMPUTING

AMBIENT
INTELLIGENCE

SMART
ENVIRONMENT

SMART
OBJECT

WEB OF THINGS

**PERVASIVE
COMPUTING**

**DIFFUSE
COMPUTING**

[3] Weiser, Mark. "Some computer science issues in ubiquitous computing." Communication of the ACM 36.7(1993)

UBIQUITOUS COMPUTING

AMBIENT
COMPUTING

AMBIENT
INTELLIGENCE

SMART
ENVIRONMENT

SMART
OBJECT

Ubiquitous Computing (Period)

An era in which the democratization and miniaturization of computers* make it possible to offer users a distributed, intuitive and possibly invisible use of computers.

*Device with computational capabilities

WEB OF THINGS

- [1] Krumm, John. "Ubiquitous computing fundamentals". Chapman and Hall/CRC, 2016.
- [2] Lyytinen, Kalle, and Yoo Youngjin. "Ubiquitous computing." Communications of the ACM 45.12 (2002)
- [3] Weiser, Mark. "Some computer science issues in ubiquitous computing." Communication of the ACM 36.7(1993)

UBIQUITOUS COMPUTING

AMBIENT
COMPUTING

AMBIENT
INTELLIGENCE

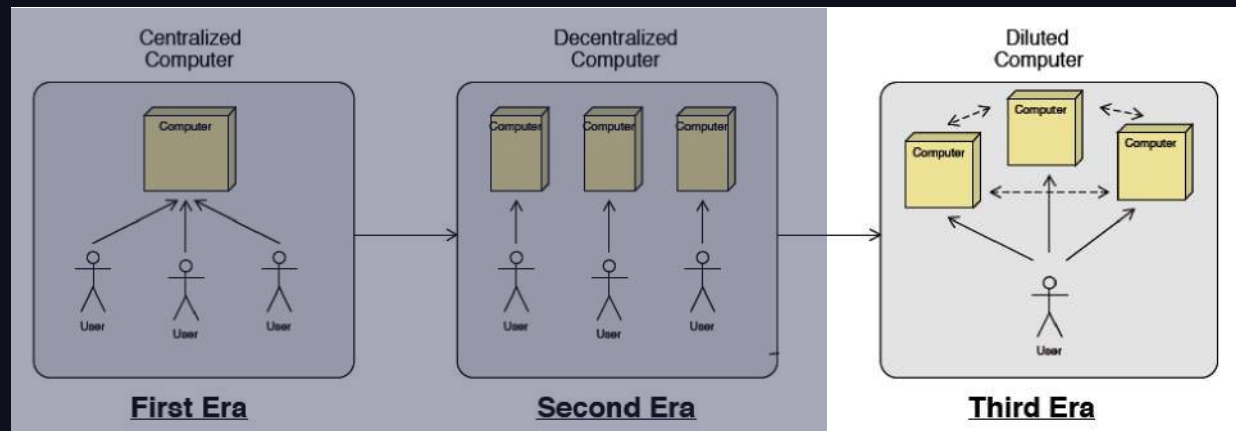
SMART
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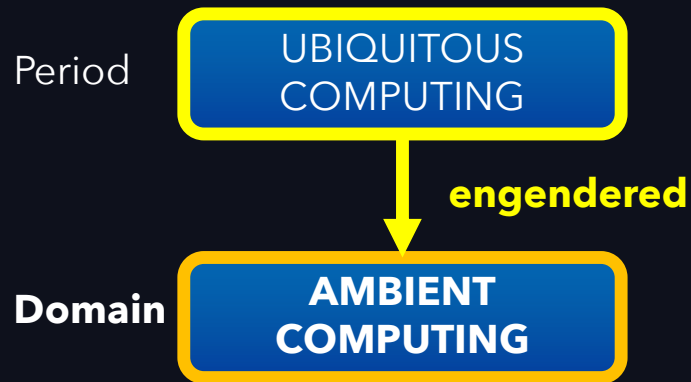
[1] J.Krumm

Period

[1] Krumm, John. "Ubiquitous computing fundamentals". Chapman and Hall/CRC, 2016.

[2] Lyytinen, Kalle, and Yoo Youngjin. "Ubiquitous computing." Communications of the ACM 45.12 (2002)

[3] Weiser, Mark. "Some computer science issues in ubiquitous computing." Communication of the ACM 36.7(1993)



Ambient Computing (Domain)

Emerging scientific domain of ubiquitous computing that aims to create ambient intelligence. This is an area touching many related fields such as : home assistance, robotics or artificial intelligence.

AMBIENT INTELLIGENCE

WEB OF THINGS

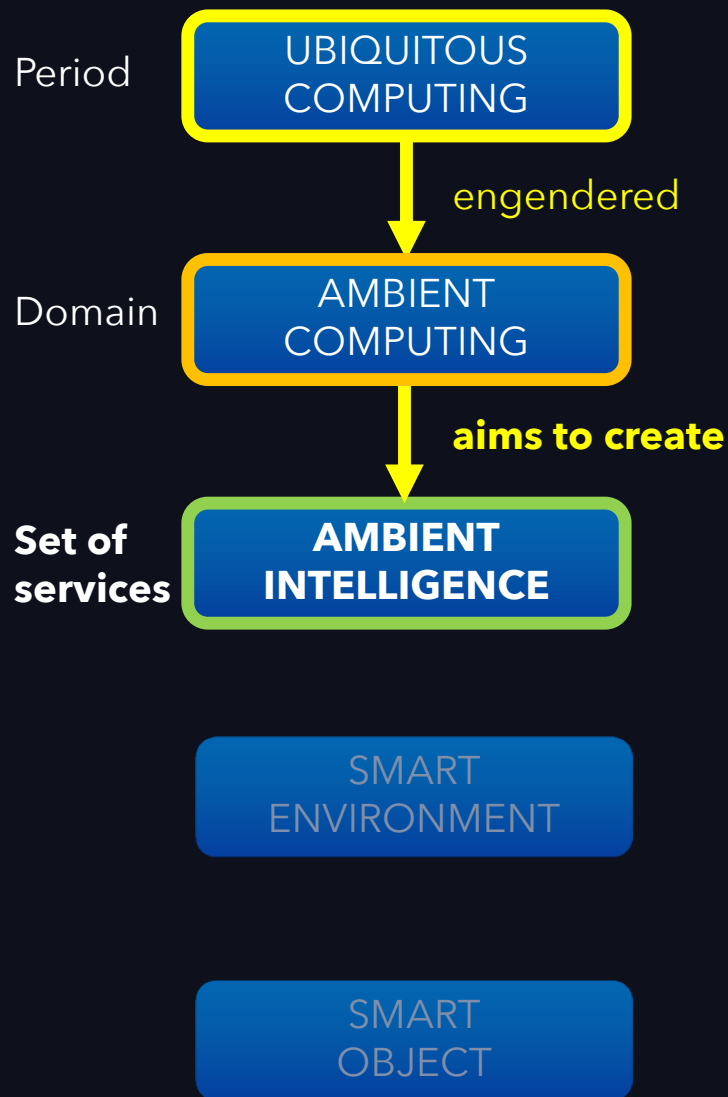
SMART ENVIRONMENT

SMART OBJECT

[4] Russell, Stuart J., and Norvig Peter. "Artificial intelligence: a modern approach.", 2016.

[5] Cook, Diane J., et al. "Ambient intelligence : Technologies, applications, and opportunities." (2009)

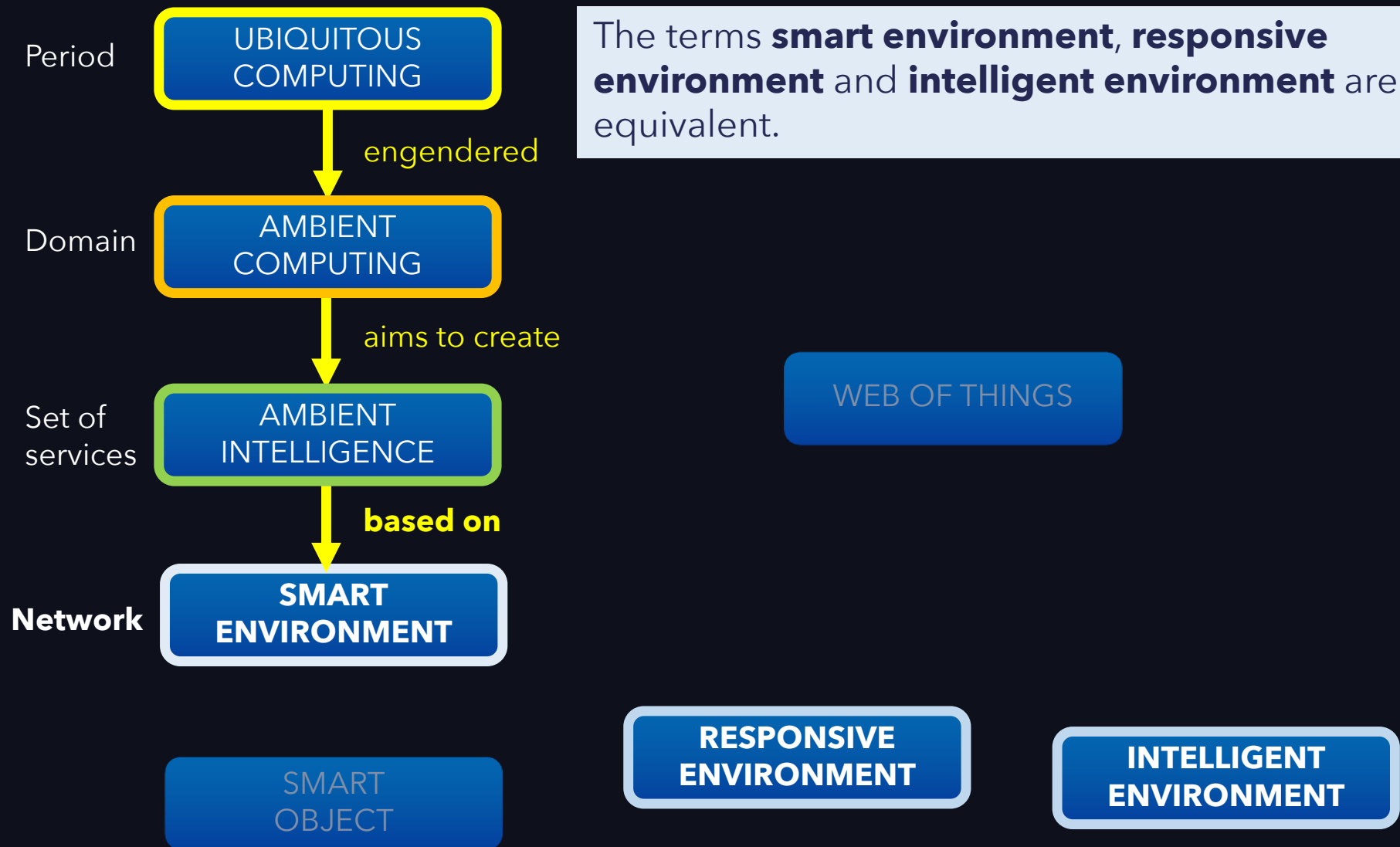
[6] Aarts, Emile, and Wichert Reiner. "Ambient intelligence", 2009.



Ambient Intelligence (Set of services)

A set of IT services which is interconnected, context-aware and naturally interactive and intelligent, in order to assist human activities. These services are based on a smart environment.

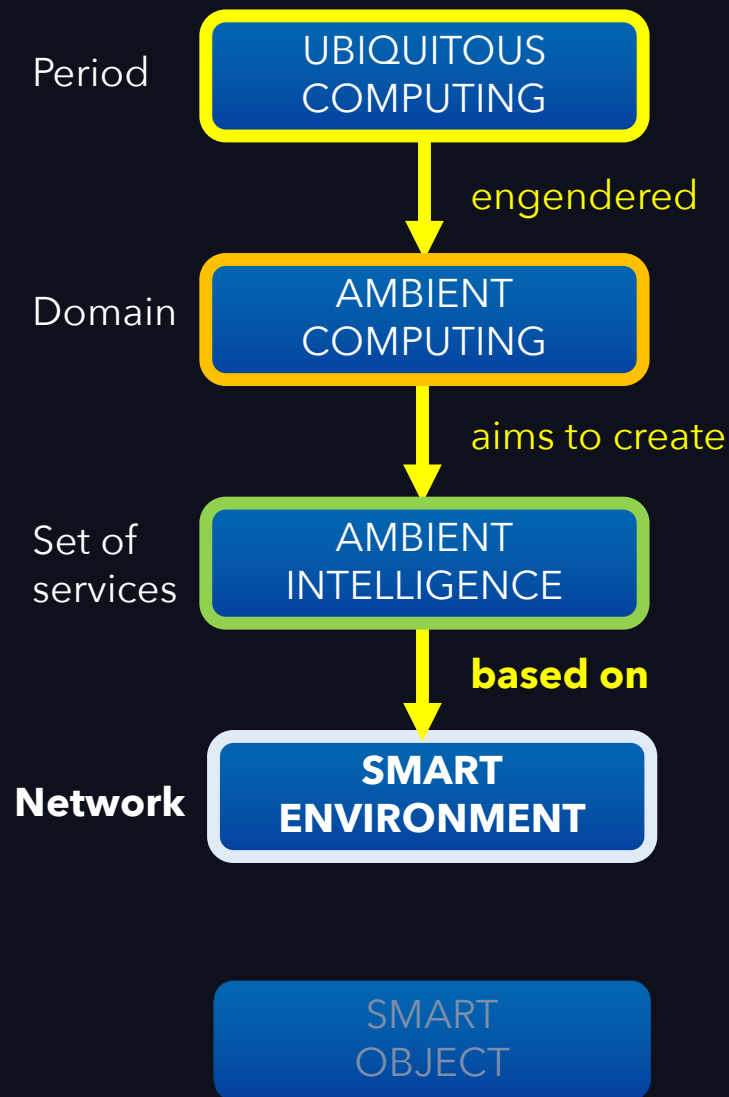
- [4] Russell, Stuart J., and Norvig Peter. "Artificial intelligence: a modern approach.", 2016.
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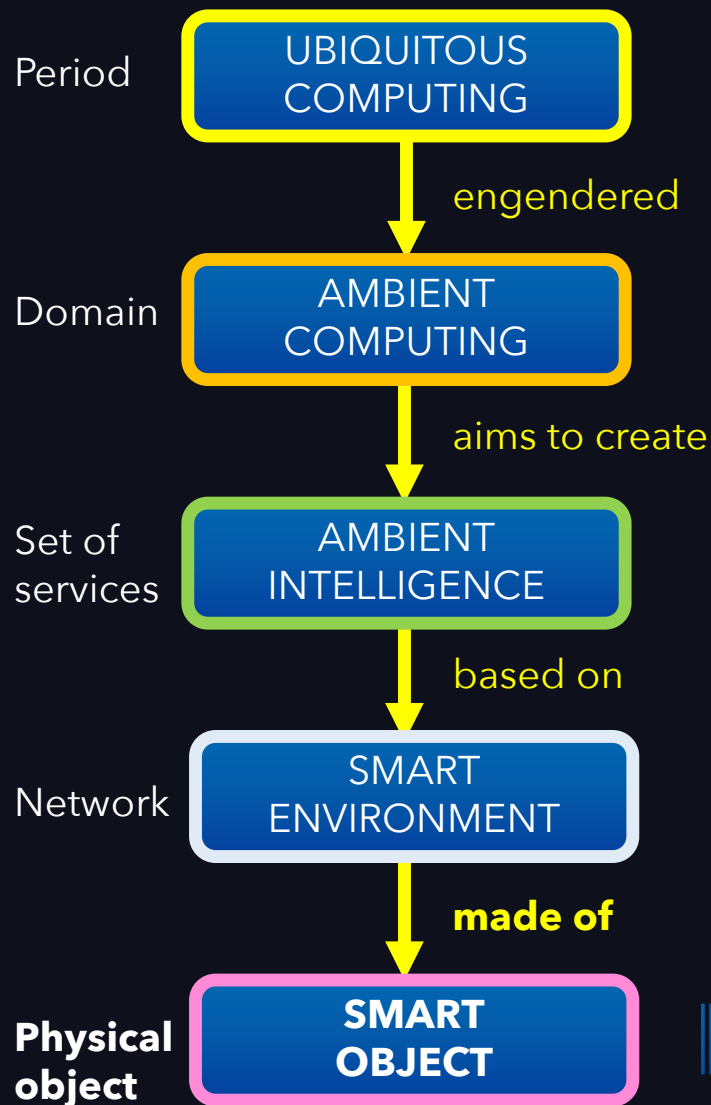
Smart Environment (Network) :

A collection of interconnected smart objects, physically situated, that provide data capture, action and computing capabilities to a set of services.

[4] Russell, Stuart J., and Norvig Peter. "Artificial intelligence: a modern approach.", 2016.

[5] Cook, Diane J., et al. "Ambient intelligence : Technologies, applications, and opportunities." (2009)

[6] Aarts, Emile, and Wichert Reiner. "Ambient intelligence", 2009.



Smart Object (Physical object)

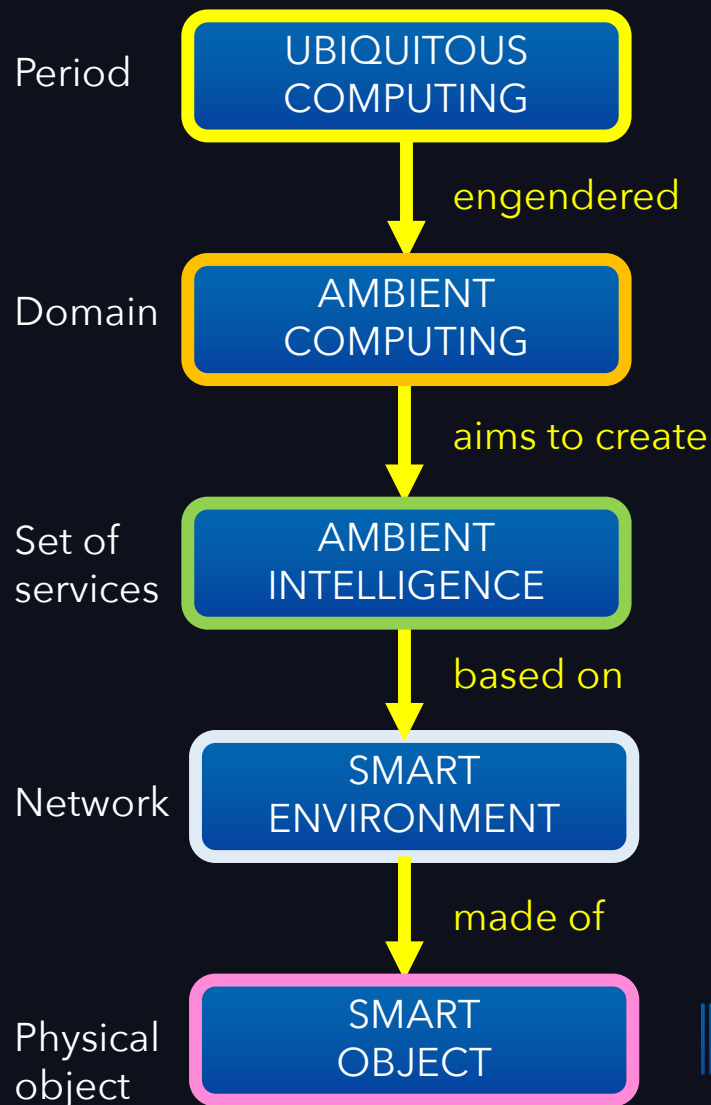
An object whose original design has no direct link with computing, but which has been augmented with computational and communication capabilities. This is the basic block for building a smart environment.

WEB OF THINGS

exemple

MEDIA CUPS

SMARTPHONE



WEB OF THINGS

Standards

Web of Thinks (Standards)

Integration of Web standards and technologies to design Web services based on interconnected smart objects belonging to the Internet of Things.

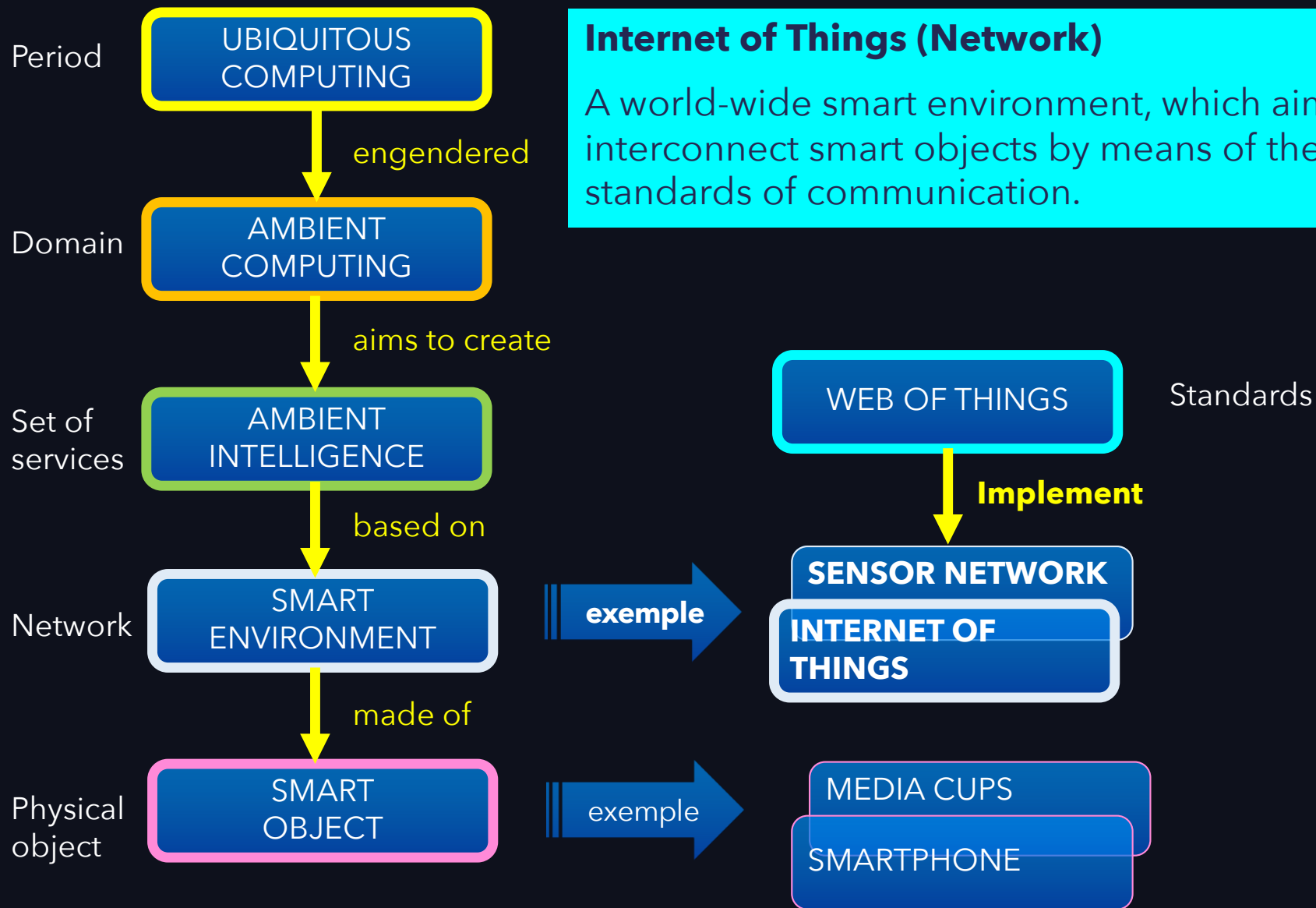
exemple

MEDIA CUPS

SMARTPHONE

[7] Ashton, Kevin. "That 'internet of things' thing." RFID journal 22.7 (2009) : 97-114.

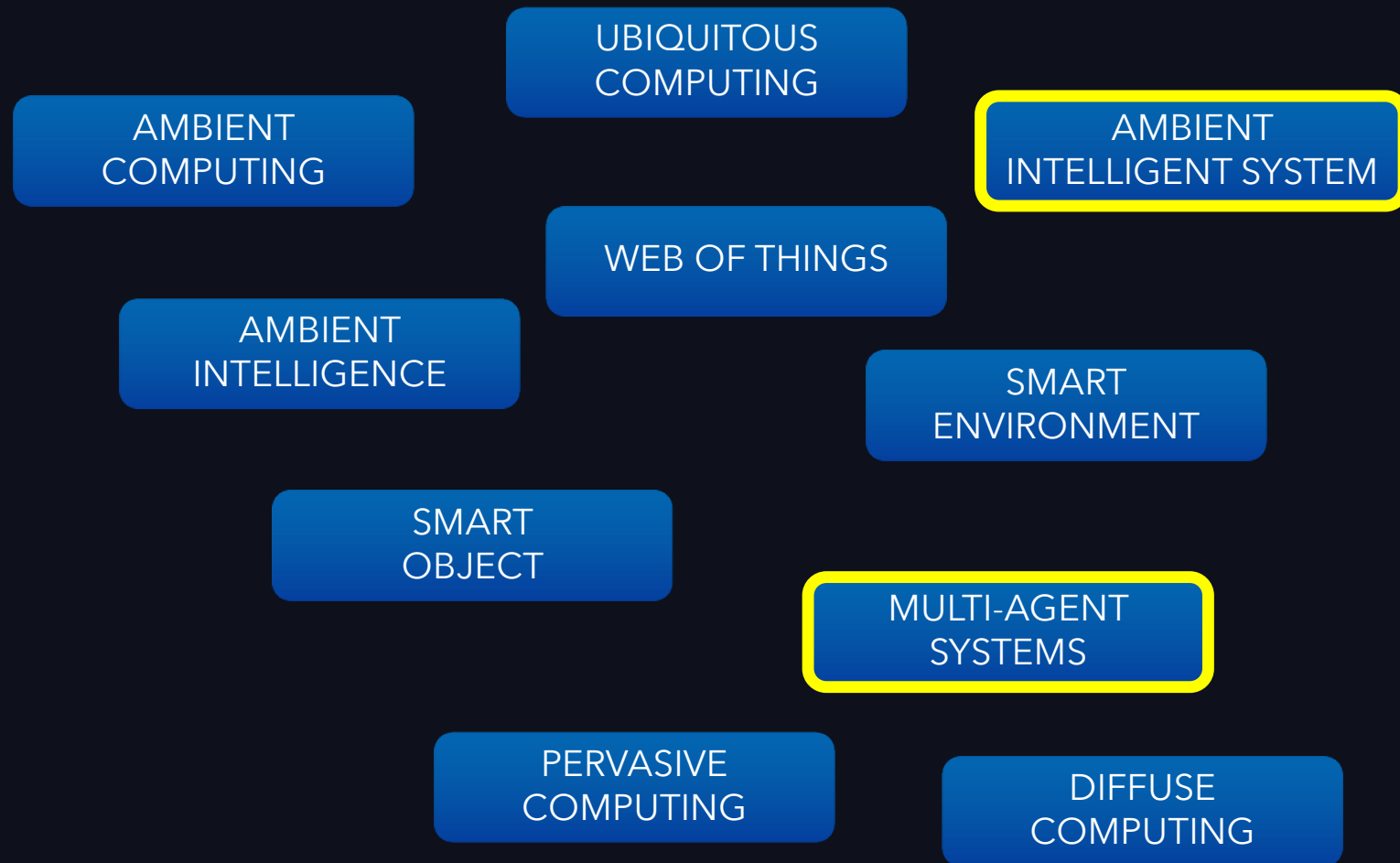
[8] Atzori, Luigi, et al. "The internet of things : A survey." Computer networks 54.15 (2010) : 2787-2805.



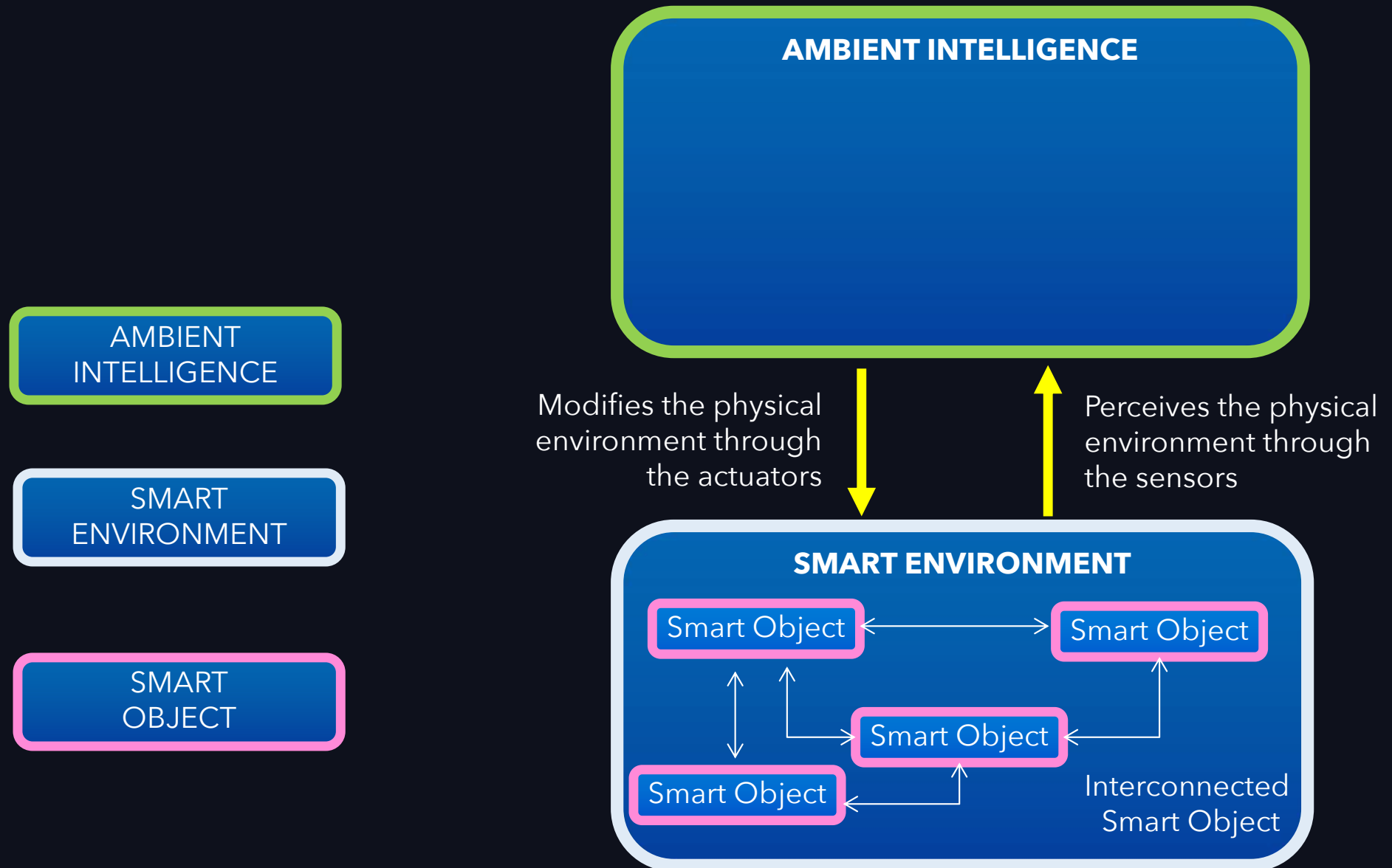
[7] Ashton, Kevin. "That 'internet of things' thing." RFID journal 22.7 (2009) : 97-114.

[8] Atzori, Luigi, et al. "The internet of things : A survey." Computer networks 54.15 (2010) : 2787-2805.

Toward a Link Between SMA and Ambient Intelligence



Ambient Intelligence System



Ambient Intelligence System

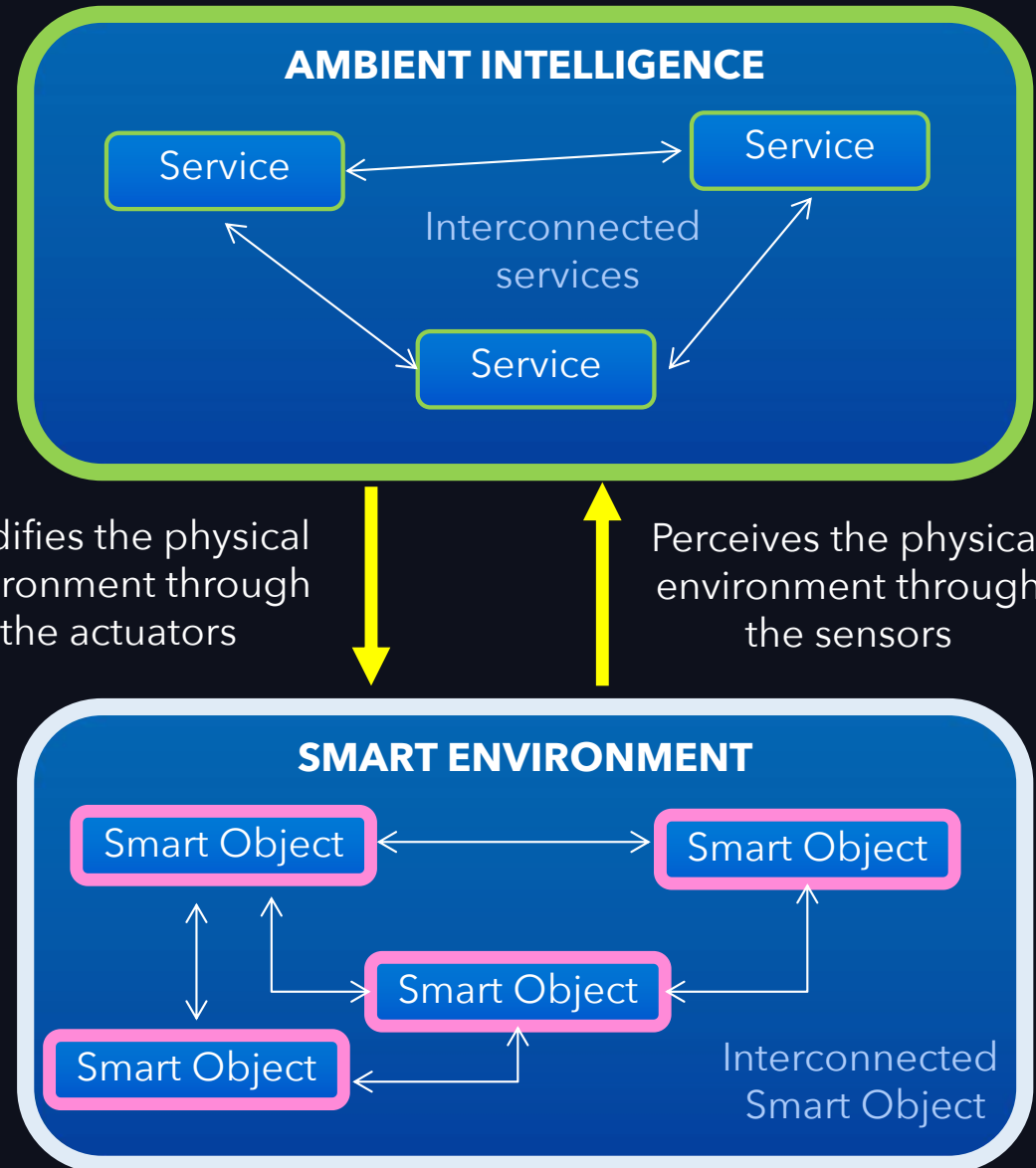
Ambient Intelligence System (set of services with network)

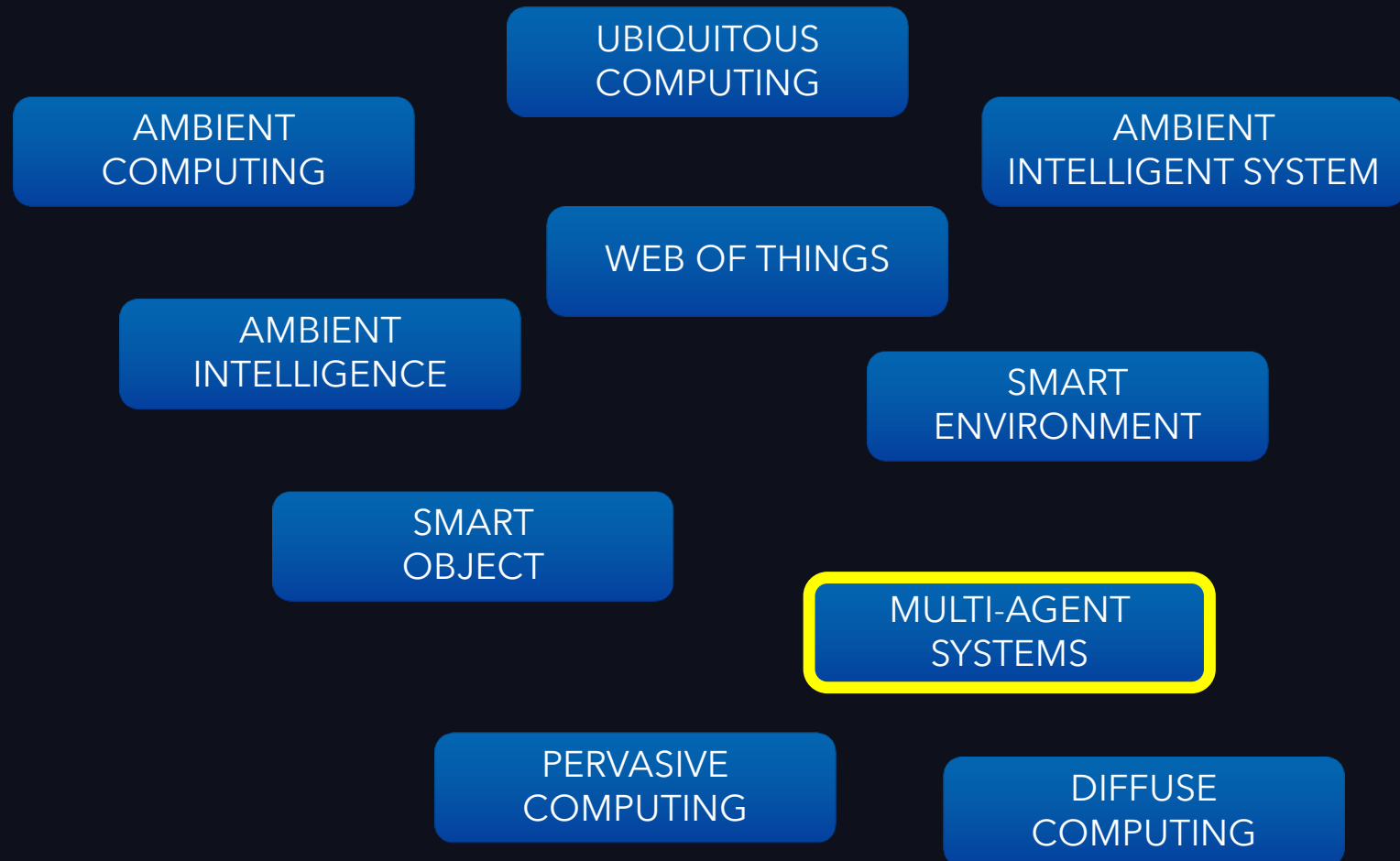
A smart environment exploited by ambient intelligence which aims to assist human activities.

[4] Russell, Stuart J., and Norvig Peter. "Artificial intelligence: a modern approach.", 2016.

[5] Cook, Diane J., et al. "Ambient intelligence : Technologies, applications, and opportunities." (2009)

[6] Aarts, Emile, and Wichert Reiner. "Ambient intelligence", 2009.



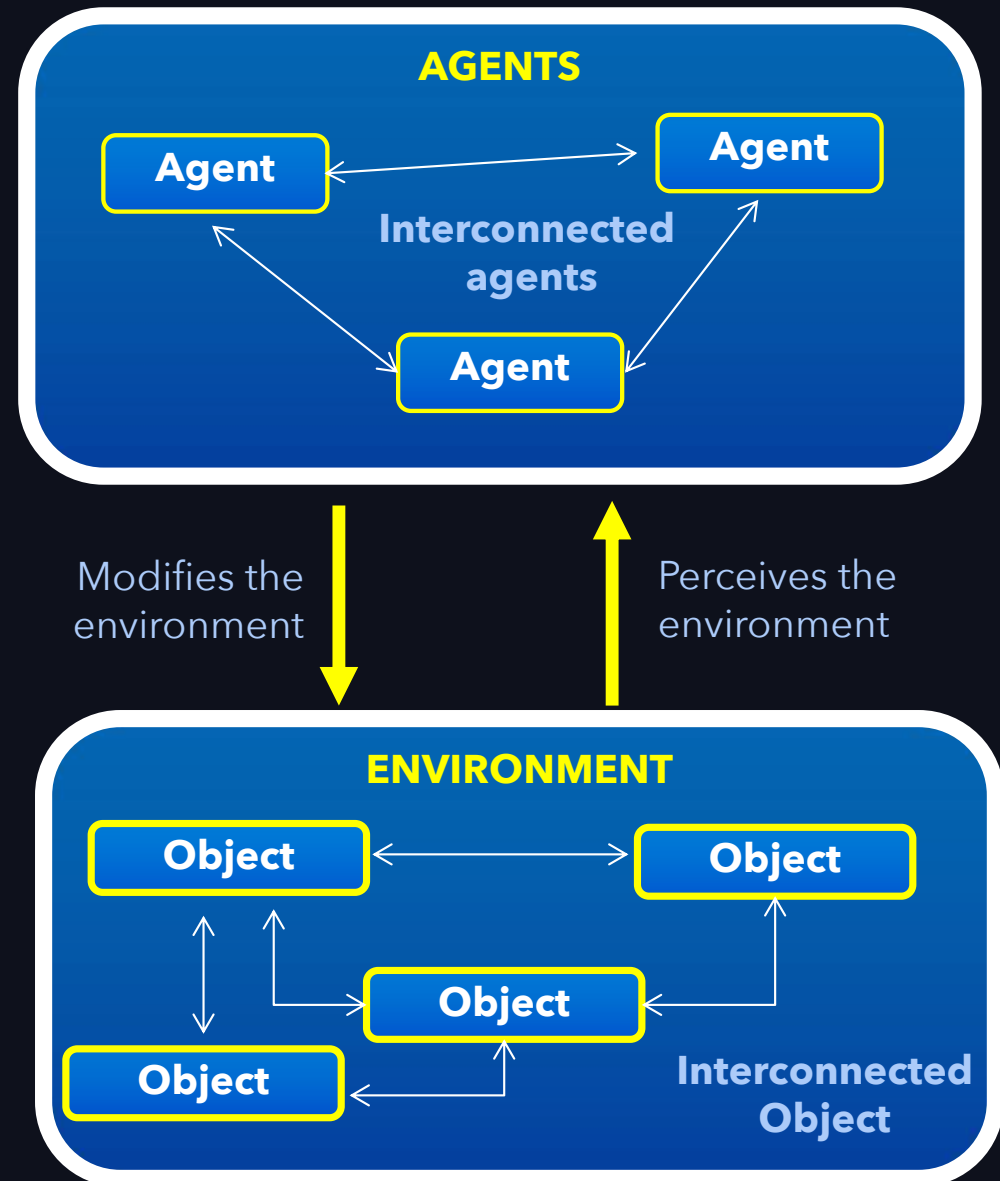


Multi-Agent Systems

A such system is made up of the following elements:

- ✓ An environment E
- ✓ a set O of objects
- ✓ a set A of agents (A included in O)
- ✓ a set of relations R which link objects between them
- ✓ a set of operations Op allowing the agents to perceive, produce, consume, transform and handle objects

[9] Ferber, Jacques, and Weiss Gerhard. Multi-agent systems: an introduction to distributed artificial intelligence. Vol. 1. Reading : Addison-Wesley, 1999.



Multi-Agent Systems

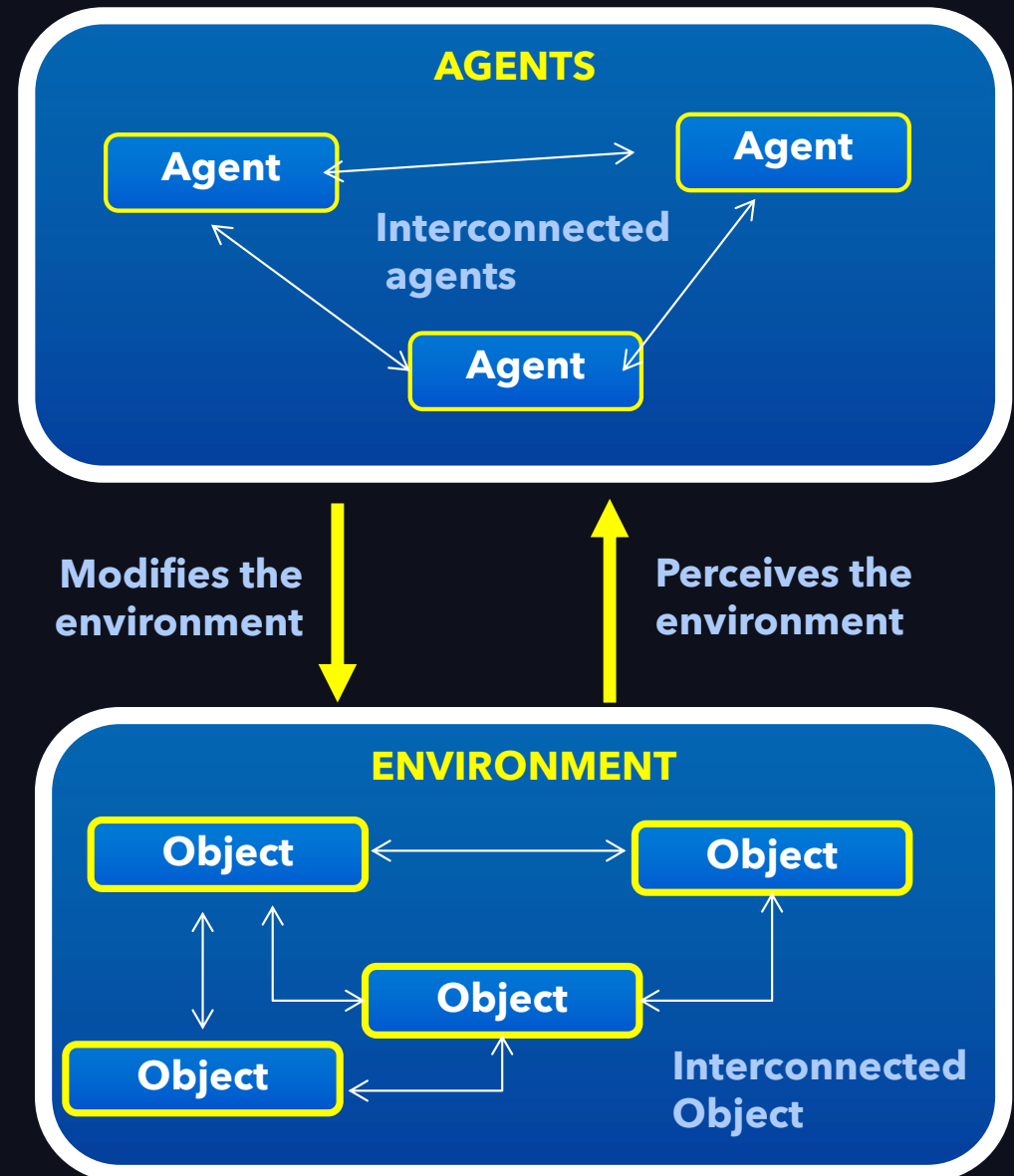
Multi-Agent System

Computer system composed of multiple software, capable of autonomous, social and possibly reactive and proactive action. A multi-agent system is based on an environment which can be empty in some case.

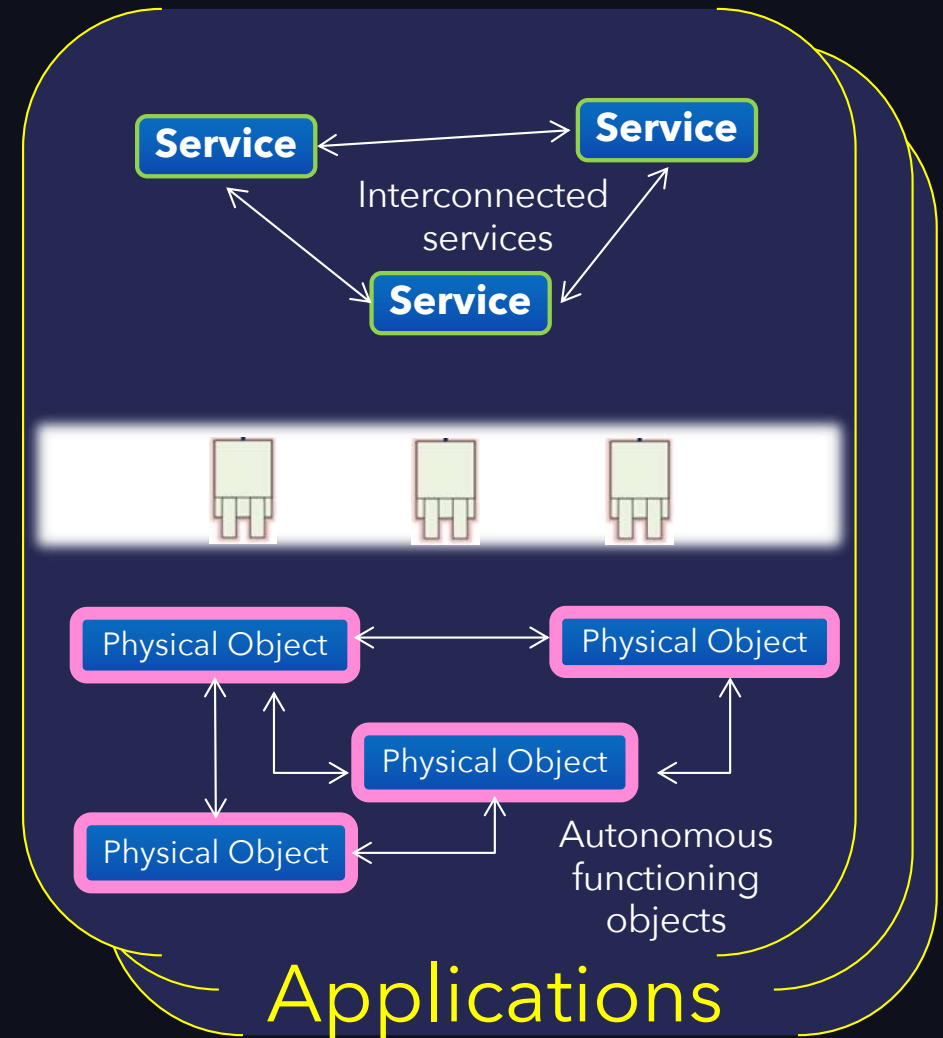
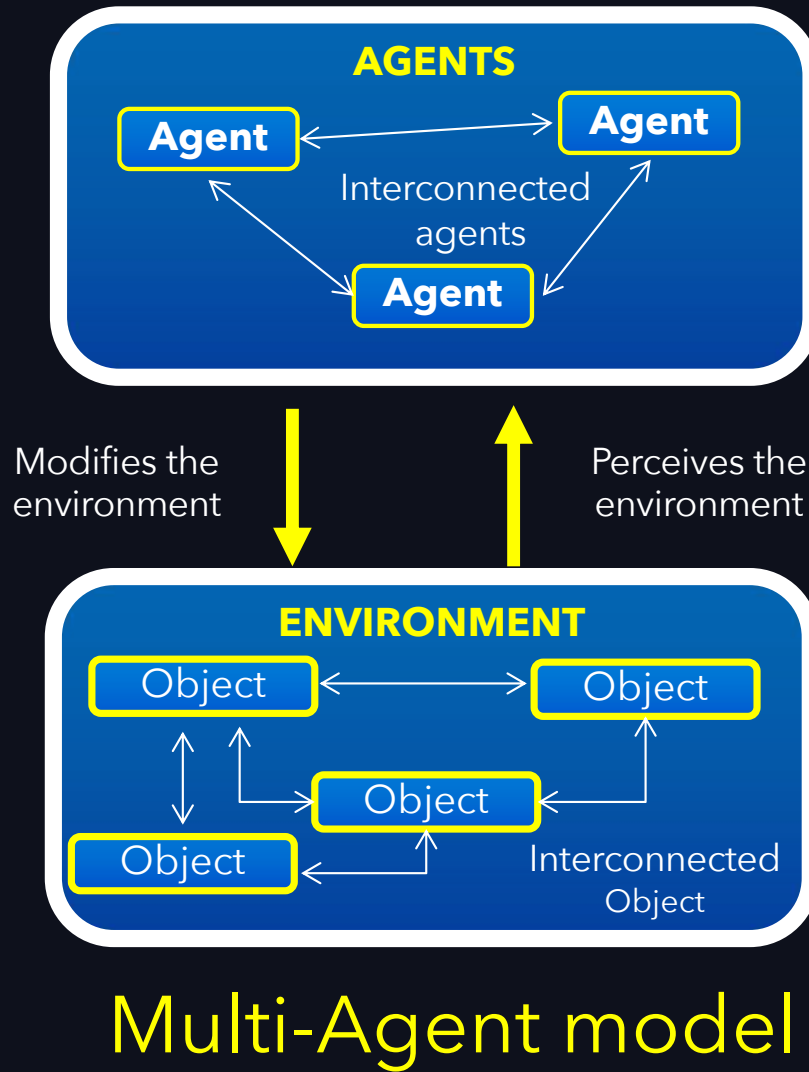
[4] Russell, Stuart J., and Norvig Peter. "Artificial intelligence: a modern approach.", 2016.

[9] Ferber, Jacques, and Weiss Gerhard. Multi-agent systems: an introduction to distributed artificial intelligence. Vol. 1. Reading : Addison-Wesley, 1999.

[10] Wooldridge, Michael. An introduction to multiagent systems. John Wiley and Sons, 2009.

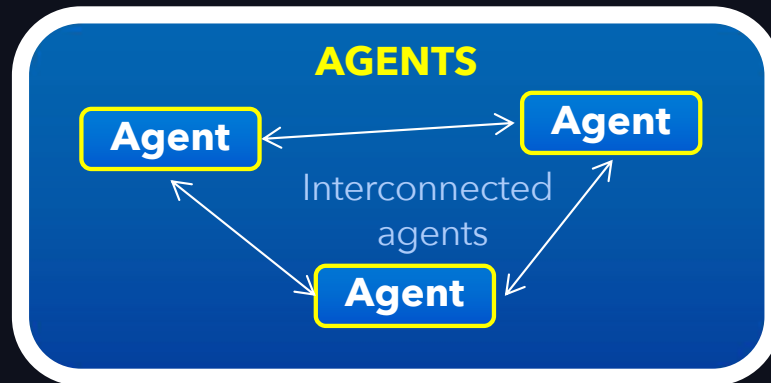


MAS application vs Ambient Intelligence System



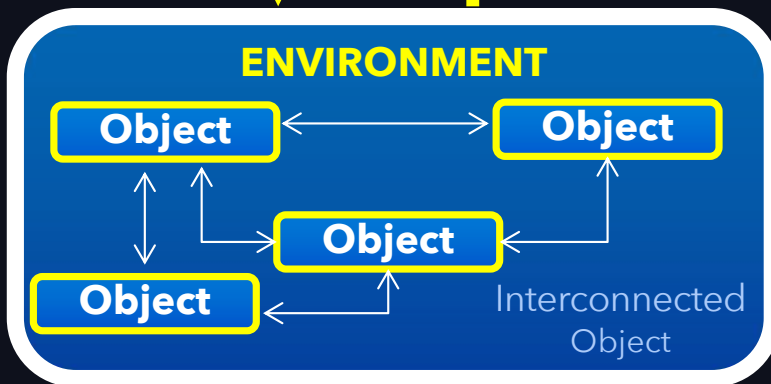
to design

MAS application vs Ambient Intelligence System

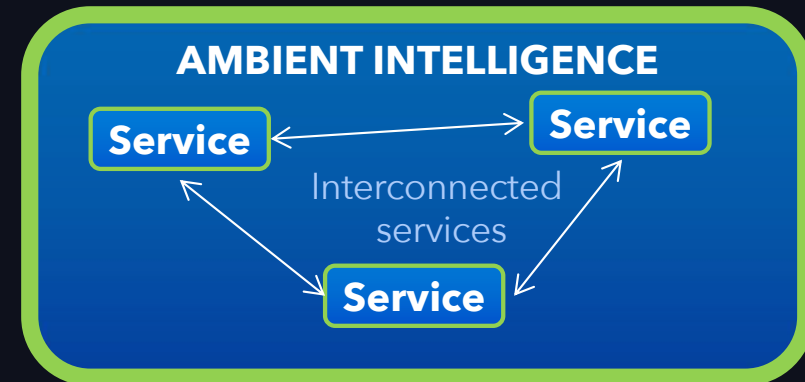


Modifies the environment

Perceives the environment

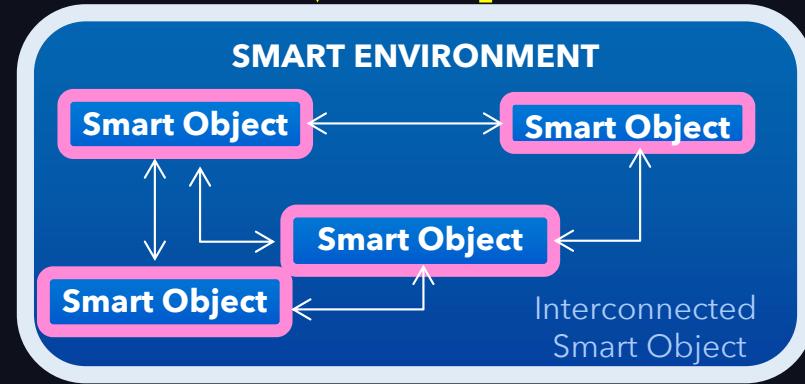


multi-agent model



Modifies the physical environment through the actuators

Perceives the physical environment through the sensors



Ambient intelligence system design framework

Nathan Aky, Denis Payet, Sylvain Giroux et Rémy Courdier –
Lecture Notes in Artificial Intelligence N° 11463, 2019.

Multi-agent systems



Ambient Intelligent Systems

Complex Systems

- Large variety of entities having specialized functions,
- Internal hierarchical levels of entities organization,
- High density of interconnections,
- Nonlinear interactions between entities,
- ...
- Collective phenomena give rise to emergent properties

**MAS
&
IoT**

Collective Interconnected Objects

Ambient intelligent Systems

Build solution for real systems

- Home socio-technical environment
- Building socio-technical environment
- Urban socio-technical environment
- Smart cities solutions

For autonomous things involved in a collective open ecosystems

Simulation

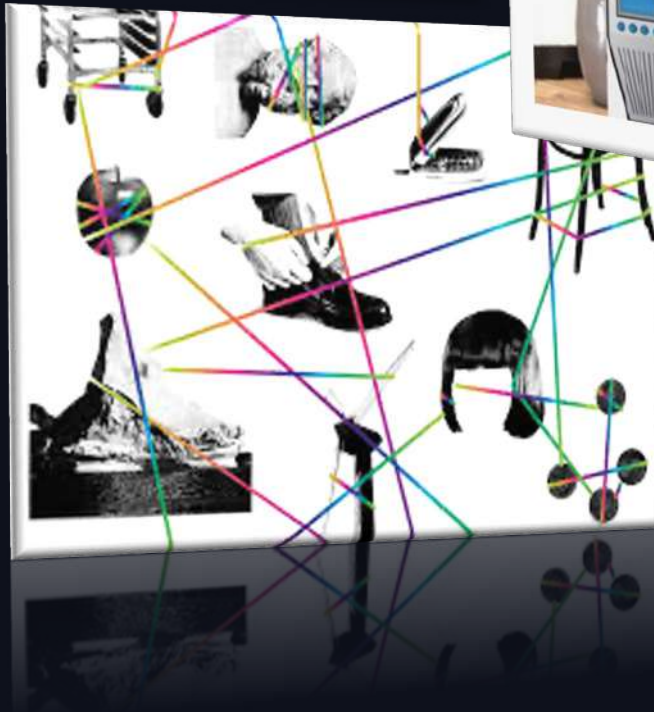
Create an abstraction of a system as it evolves over time:

- Facilitates the validation of scientific assumptions.
- Enhances the comprehension of system dynamics.
- Serves as a decision-making aid.

For systems where direct observation and measurement are not possible:

- They cannot be reproduced.
- They cannot be experimented upon.

Adaptation comes from the environment



The world in which we live invades us with electronic (micro-controller) and digital (microprocessor) devices.

This defines our everyday digital environment, and it is radically different from the one that was still, not so long ago, confined to our computers

The notion of computer system today ...

Dozens or even hundreds of computer components, which can:

- be embedded in many objects,
- work with all kinds of sensors and actuators,
- communicate with each other and provide more and more sophisticated services.

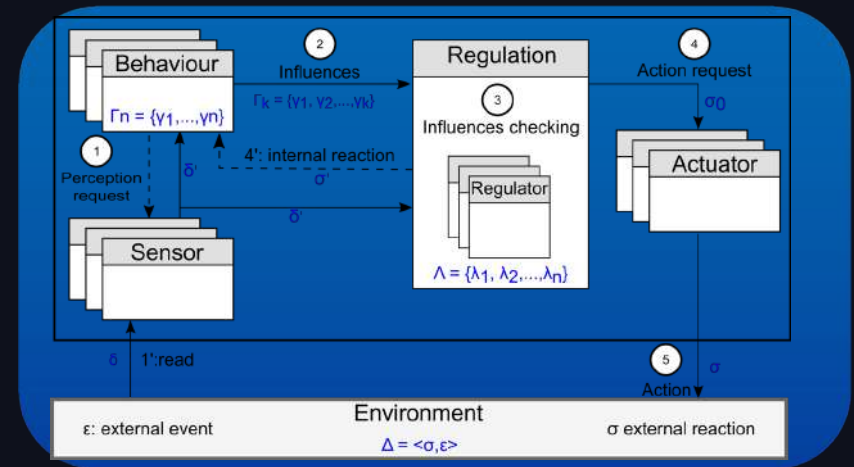
This new type of computer system is at the heart of **Collective Adaptive Systems**
(Systèmes Collectifs Adaptatifs)

- **Collective** because groups of entities collaborate together
 - ✓ to achieve a common goal,
 - ✓ or use the synergy of the group to reach their own goal in a combined way.
- **Adaptive** because these groups are able to change their goals, organizational structures, and services at any time depending on the situation.

Exemple

A multi-agent approach
for diffuse monitoring
and assistance applied
people losing their
autonomy

Software Kit for
Ubiquitous Agent
Development



At home

urban environment



UNIVERSITÉ DE
SHERBROOKE

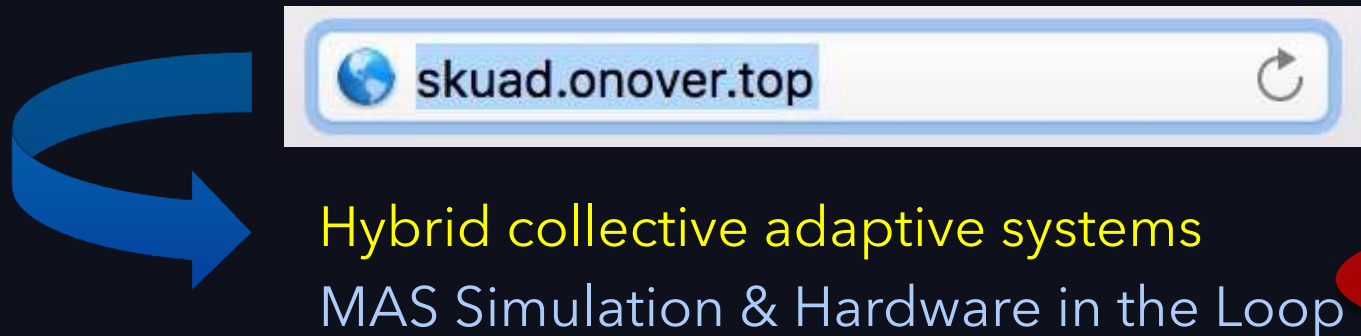
Cooperation
with the
DOMUS Lab,
Sherbrooke
University, CA



Example of an experimental platform

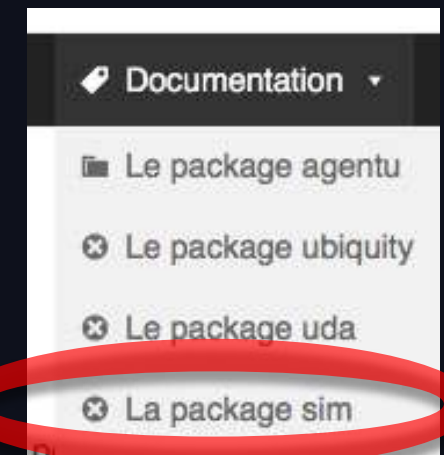
SKUAD: Software Library development
Software **K**it for **U**biquitous **A**gent **D**evelopment

A compact software library that can run on nano-computers and allows the management of ambient agents, sort of autonomous software components able to evolve in real time in our physical environment (ambient).



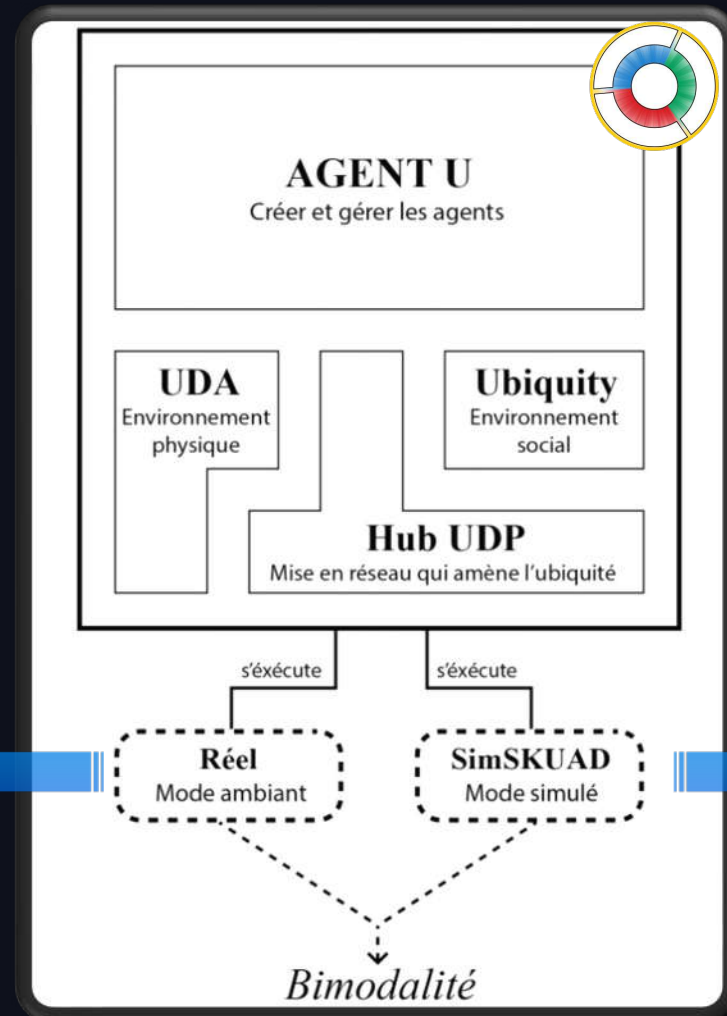
Hybrid collective adaptive systems

MAS Simulation & Hardware in the Loop

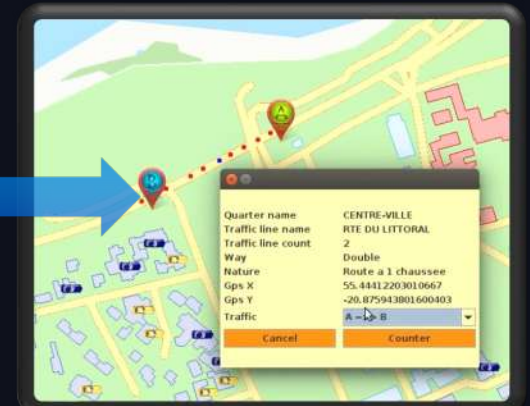


Toward an hybrid ambient intelligent systems

Hybrid MAS framework allows ambient agents connected to real devices to be substituted for fully simulated virtual devices without changing the computer code.



SKUAD Runtime



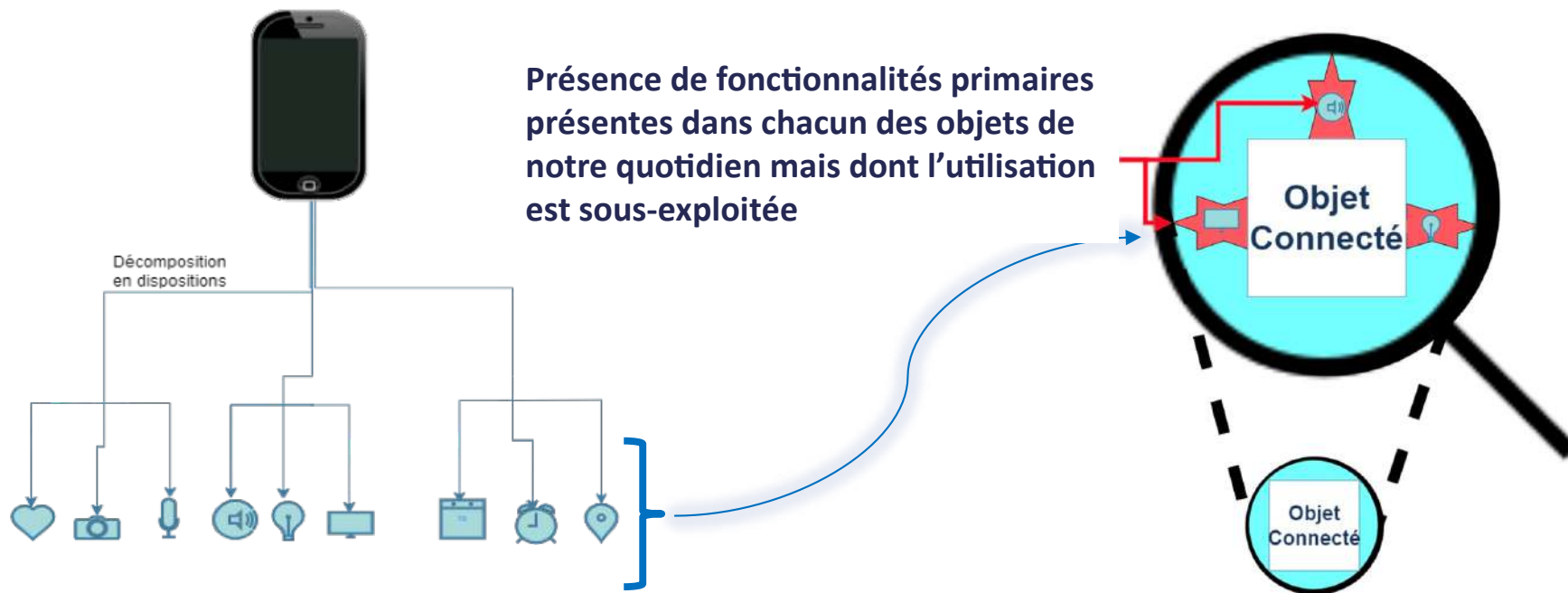
Squad architecture diagram

Ecoconception in Smart Ambient Systems

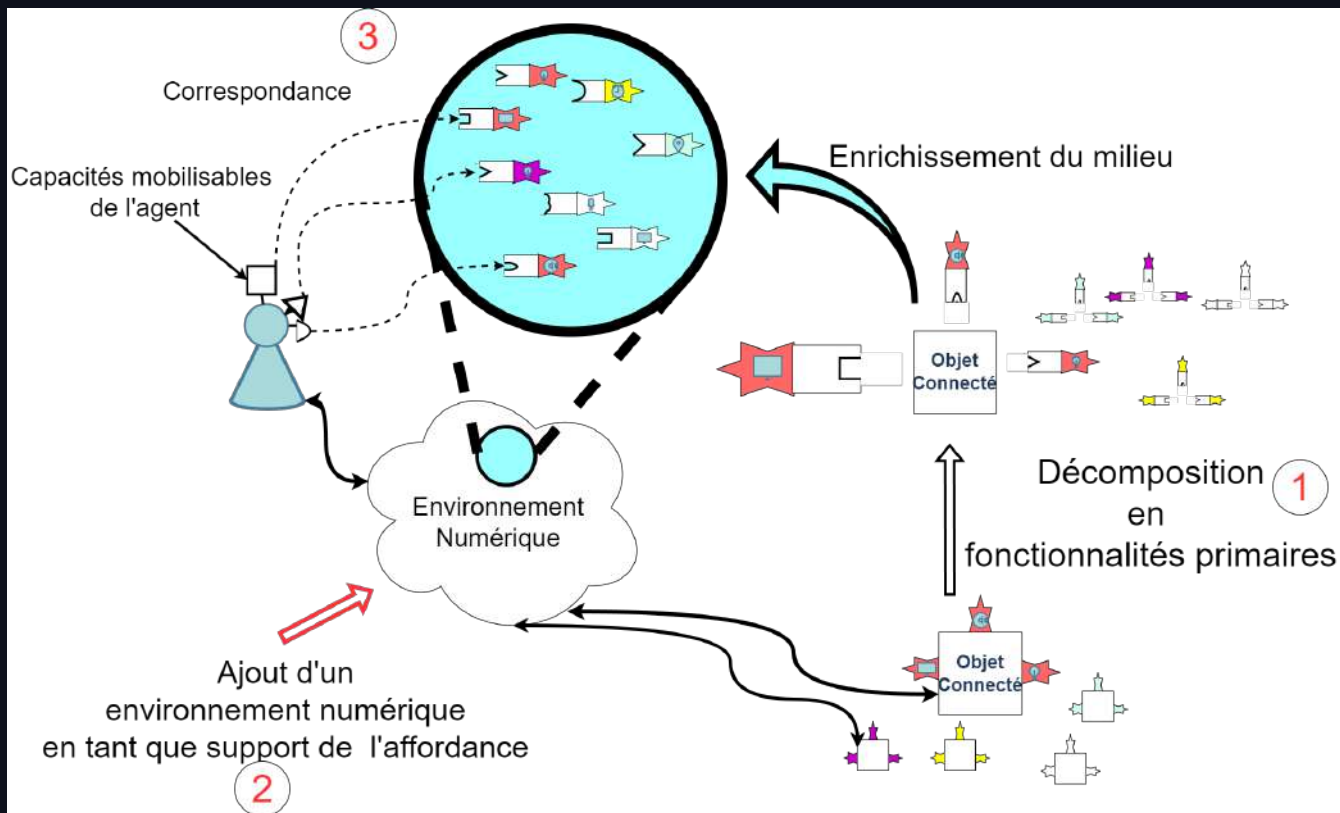
Limiter l'impact écologique lié à la surabondance des appareils

Idée : Rendre l'utilisation d'une ressource informatique possible au-delà de l'objet qui le porte.

-> proposition d'un modèle conceptuel générique de décomposition et de mutualisation des possibilités réelles de nos ressources connectées.



Work with affordance in real environment



Composition adaptative des services :

Notion Agent préemptif capable de recomposer dynamiquement des services grâce à la détection des affordances.

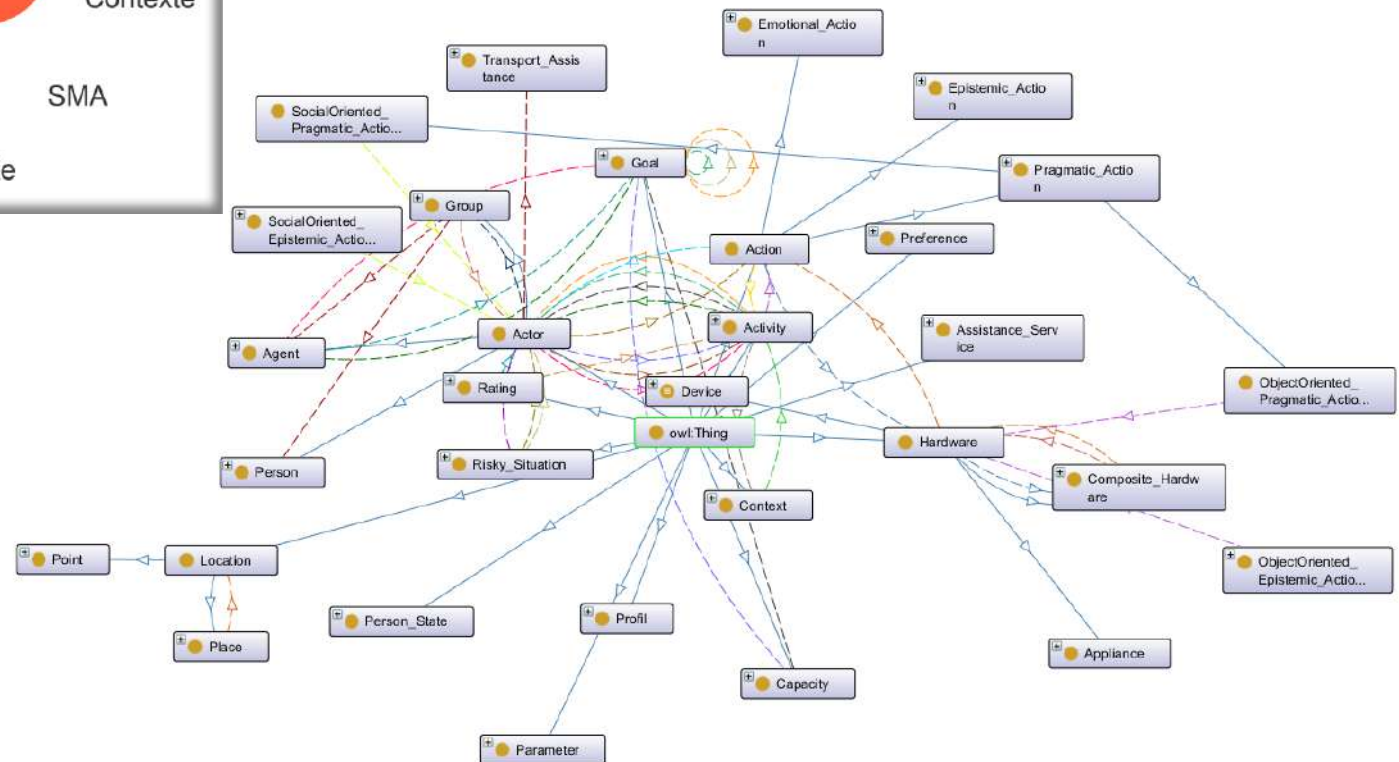
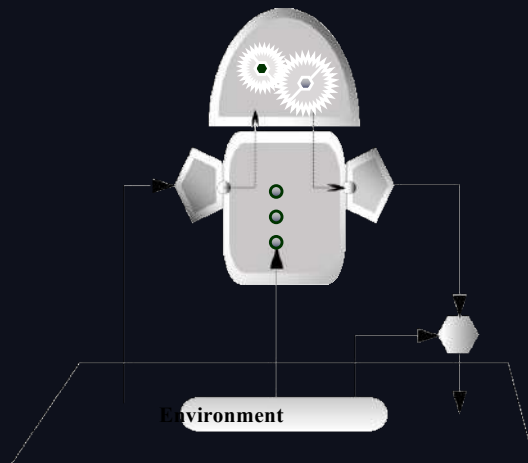
- **limiter la charge cognitive liée à la gestion de l'environnement**
- **tirer profit d'un maximum d'objets connectés.**

Working with agents and ontologies



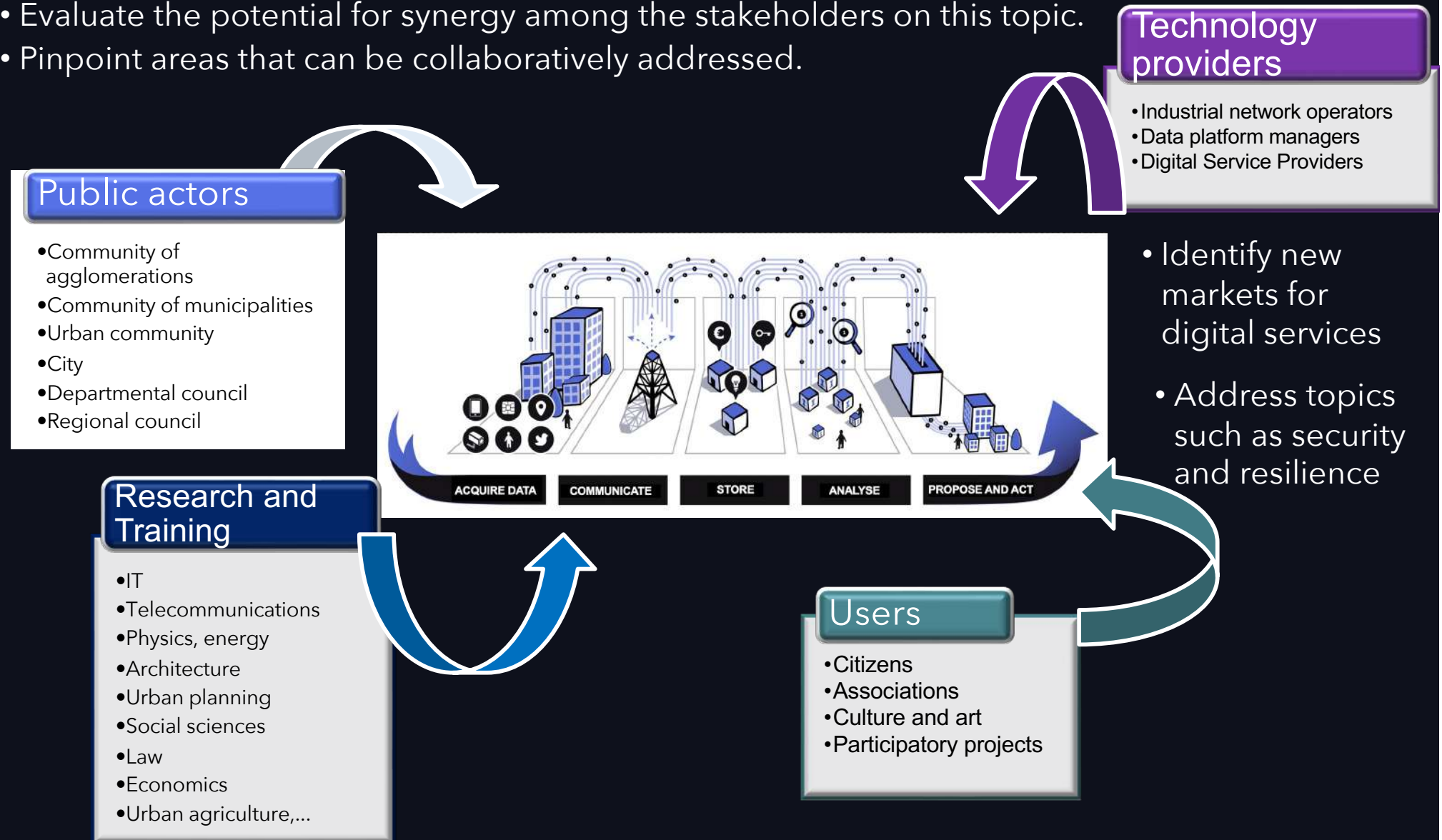
Ontology metrics:

Metrics	
Axiom	1642
Logical axiom count	1127
Declaration axioms count	314
Class count	87
Object property count	53
Data property count	34
Individual count	142
Annotation Property count	4



SMA and Smart city

- Identify the key stakeholders involved.
- Assess the actions they have undertaken within their respective organizations.
- Evaluate the potential for synergy among the stakeholders on this topic.
- Pinpoint areas that can be collaboratively addressed.



Bridging the Gap with Civil Society



Laboratoire
d'Informatique et de Mathématiques
[Groupe "Systèmes Collectifs Adaptatifs"]



RESEARCH

TEACHING

ADMIN

EVENTS

PROJECTS

Accueil » Projects » Video series on smart city

"Causeries" video series on smart cities

Dernière mise à jour le vendredi 30 septembre 2022 à 17:50

Series of talks on "Smart Cities" on Youtube and Facebook

Production: : Université Numérique de La Réunion [UNR], **Scientific director** : Prof. Rémy Courdier,

Collection: : "Sciences and Society", **Series:** : "Smart Cities", **Language:** : "fr".



[#1 - Definitions & characteristics of smart cities](#)



[#2 - Challenges & experiments of smart cities](#)



[#3 - Key concepts of smart cities](#)



[#4 - Benefits and limitations of smart cities](#)