Paradigm Shifts in Health Informatics

Luca Dan Serbanati and Serban Radu

Politehnica University, Bucharest, Romania

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Agenda

1. **What is a paradigm?**
   - "Canon of proportions" => "Vitruvian Man"
2. How can we use a paradigm?
3. New paradigms in healthcare
   - "Pay for performance", "Personalized medicine", etc.
   - "Patient-Centered Care"
4. Shift of paradigms from business to healthcare
   - "Business Meta-Model"
   - "HL7 RIM Meta-Model"
5. Paradigm shifts of from information engineering to ehealth
   - "Interconnecting Health"
   - "Integrating health"
6. New paradigms in health informatics
   - Multi-agent system
   - "R2V2R - Real-to-Virtual-to-Real"
   - "Ecosystem"
7. Conclusions

Example of Paradigm Shift

- Vitruvius described the human figure as being the principal source of proportion among the classical orders of architecture.

Architecture

- Paradigm:

Canon of Proportions:

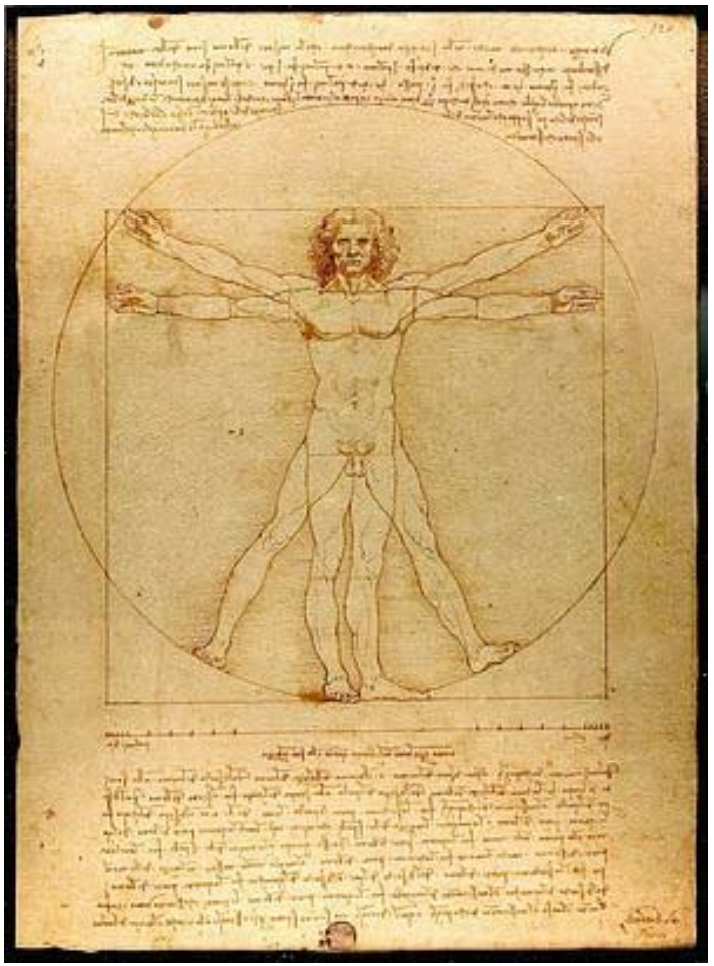
Human body proportions are the golden proportions of architectural styles

Paradigm shift

Cosmography of the microcosm, Art, Science

- Leonardo da Vinci believed the workings of the human body to be an analogy for the workings of the universe.

Homo Vitruvianus



What is a paradigm?

Definition:

A reference model of fundamental value widely accepted in a particular field because it is an expression of a comprehensive belief system or world view in that field.

- Usually a paradigm emphasizes relationships between some fundamental concepts that shape the thinking.
- A paradigm is derived from a specific way of thinking, communicating and viewing the world.

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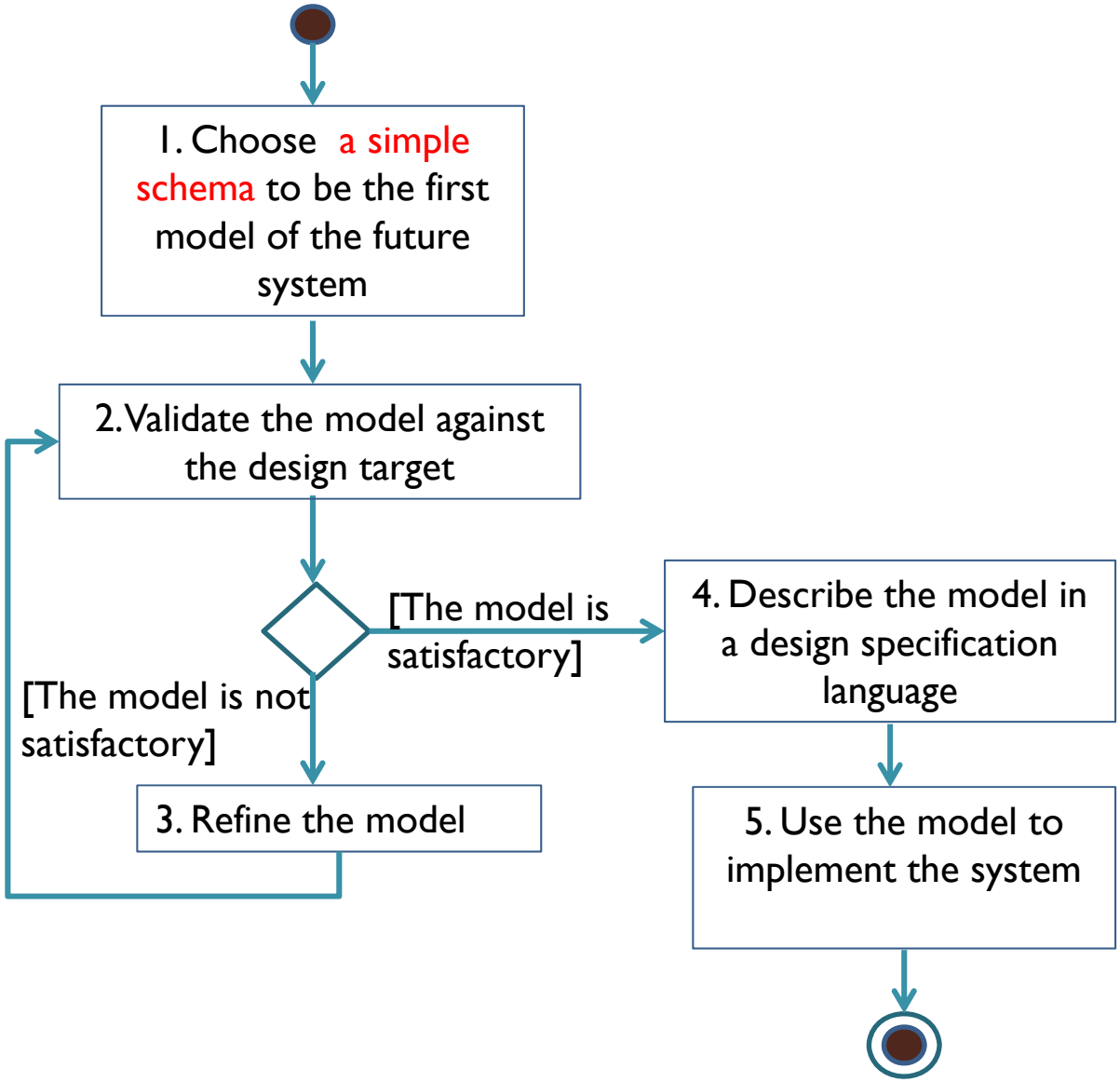
How to use a paradigm?

- A paradigm influences how an individual perceives an area of the real world or reacts to this perception.
- A paradigm guides research and practice in the field of interest.
- It can be used as:
  - a structuring schema in both teaching and model-driven design processes;
  - a benchmark to assess methods or conceptual tools that are related to the paradigm goal or idea, and
  - as this research claims, we can use paradigms for transferring knowledge across domains.

Model-based design process



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New paradigms in healthcare

- New paradigms are arising in healthcare to mark epochal changes in the domain:
  - "pay for performance“ focuses on cost control
  - "personalized medicine" and "evidence-based medicine“ focus on the quality of services
  - "patient-centered care” and "patient empowerment" focus on the citizens’ perception concerning the quality and efficiency of healthcare.

"Patient-Centered Care" Paradigm

"Nothing about me without me"

Or:

The right care in the right way at the right time.

Method

- Four new communication behaviors:
  - Understanding and validating the patients' perspective
  - Extension of understanding the patient to his / her global psychosocial context
  - Shared understanding with the patient of his / her health problem and its treatment
  - Partnership with "empowered" patients in decision making, power and responsibility.

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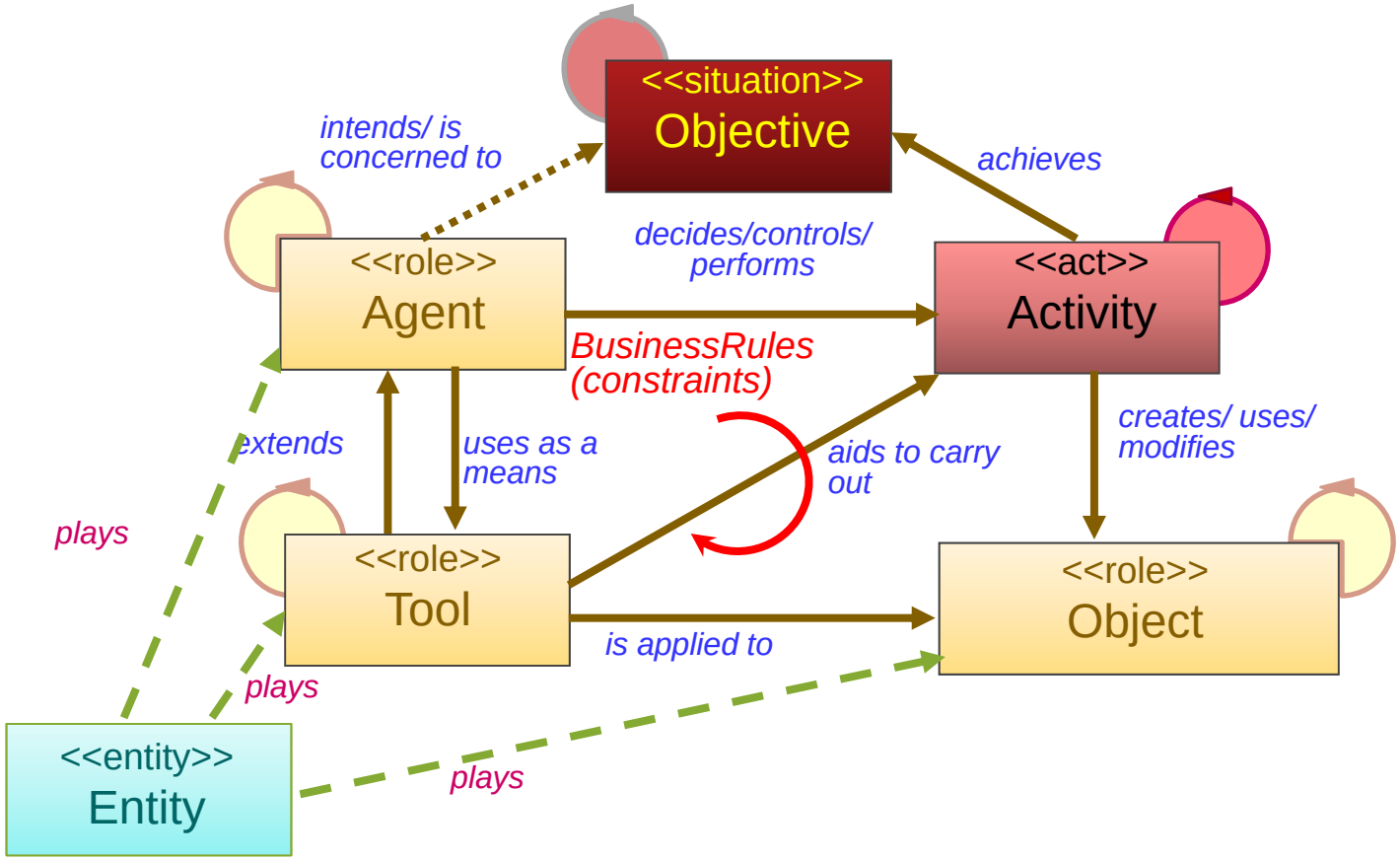
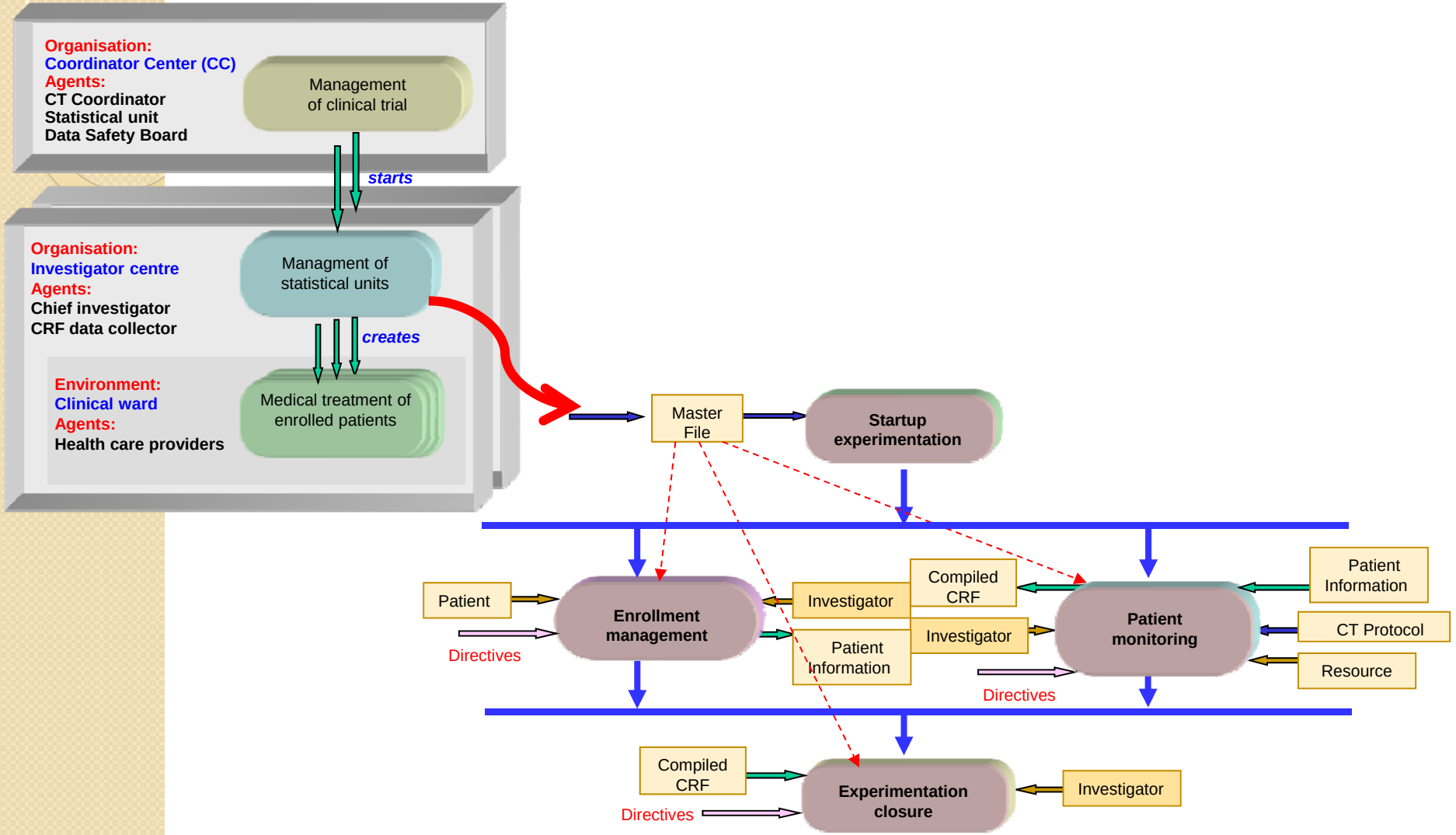
A business meta-model*)



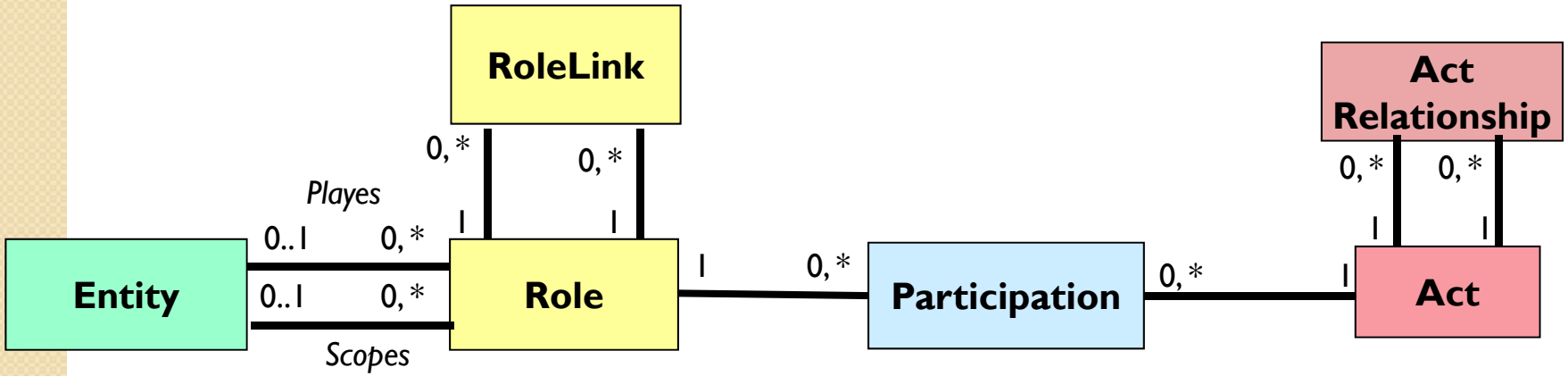
*) L. D. Serbanati, *Integrating Tools for Software Development*, Yourdon Computing Series, Prentice Hall, 1992.

A Business Model of Clinical Trials *)



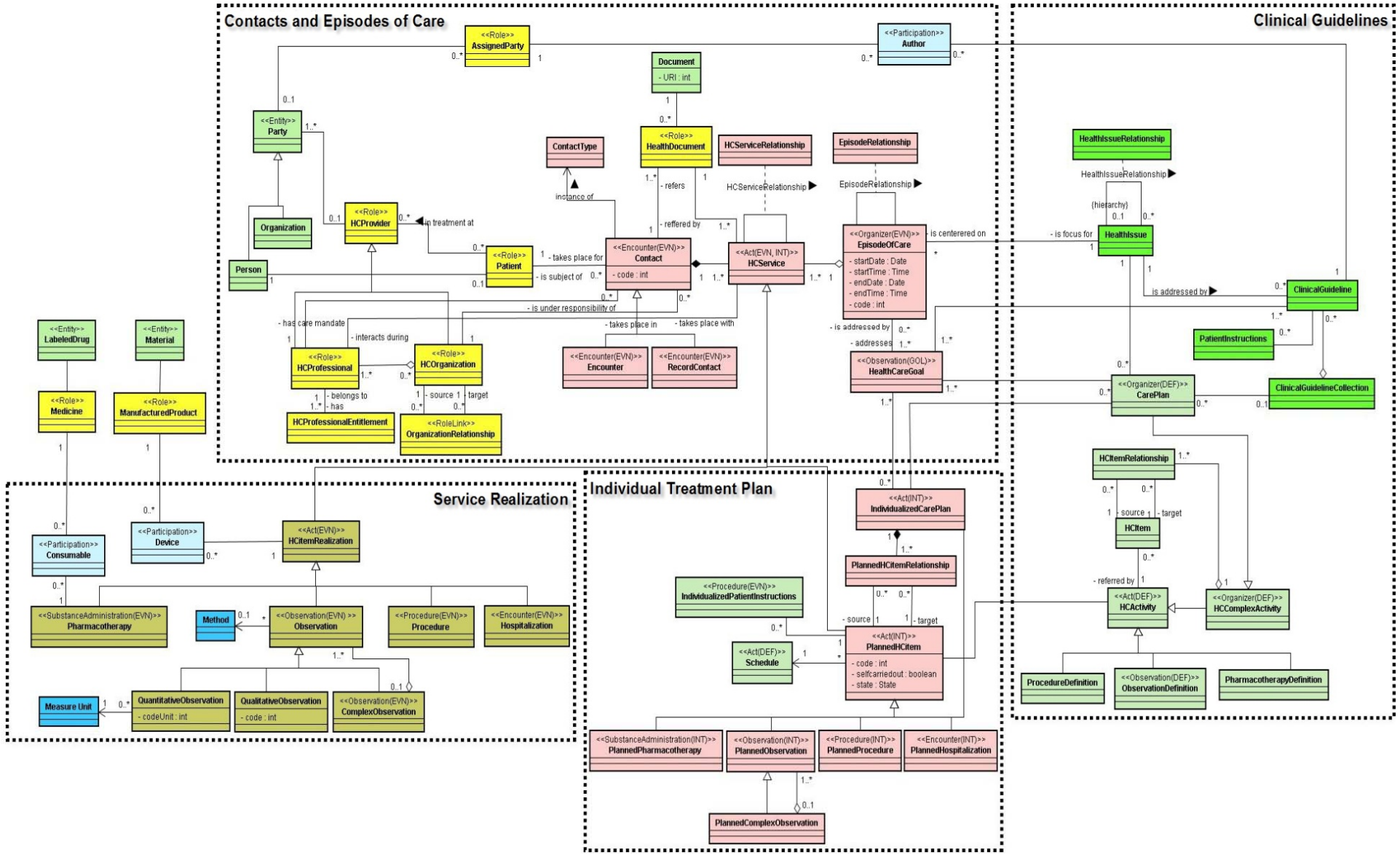
*) L. Collada Ali, P. Fazi, D. Luzi, F.L. Ricci, L.D. Serbanati, M.Vignetti, *Toward a Model of Clinical Trials*, ISBMDA 2004, 5th International Symposium of Biological and Medical Data Analysis, Barcelona, 2004.

The RIM HL7 V3 Meta-model *)

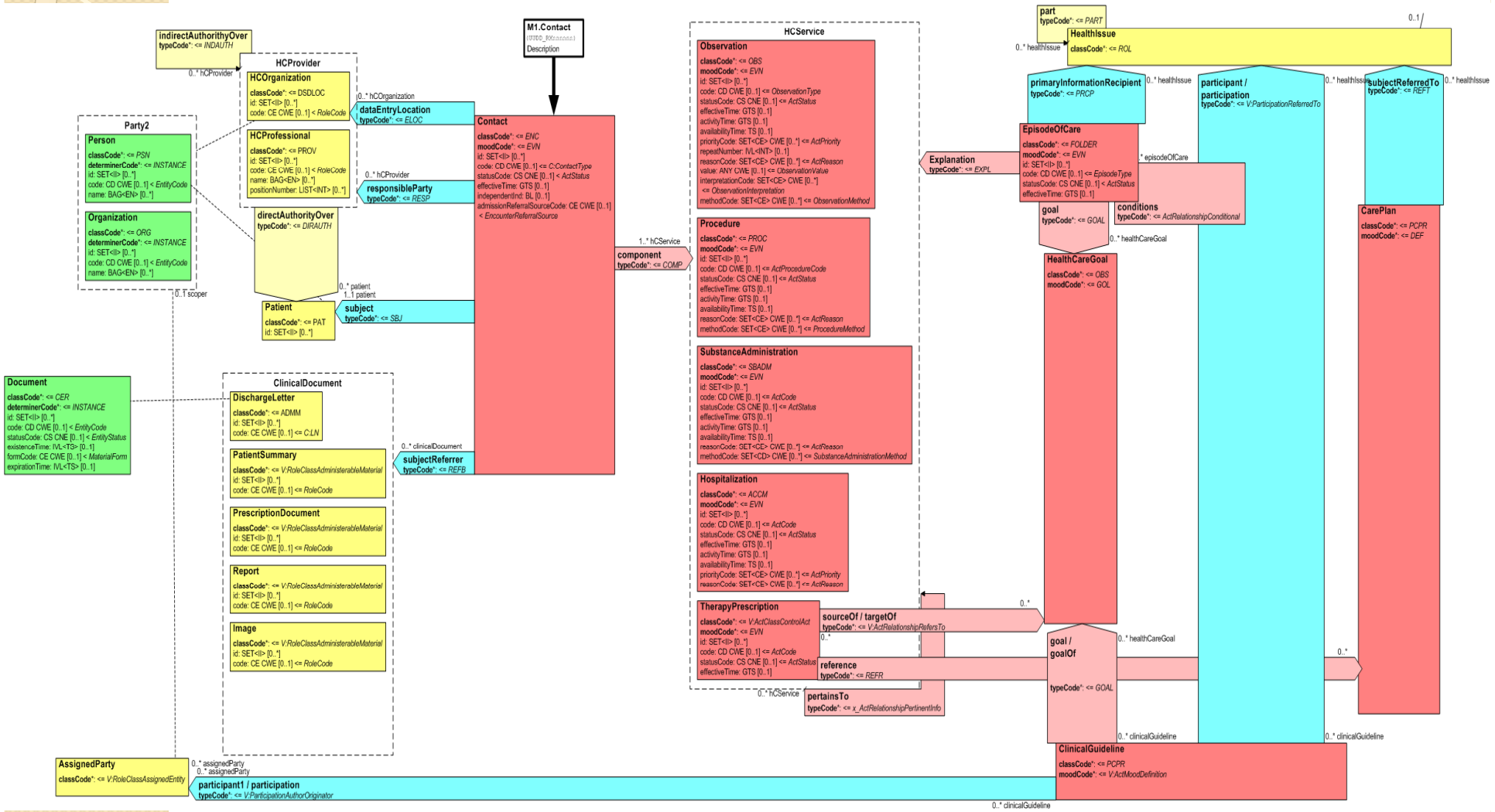


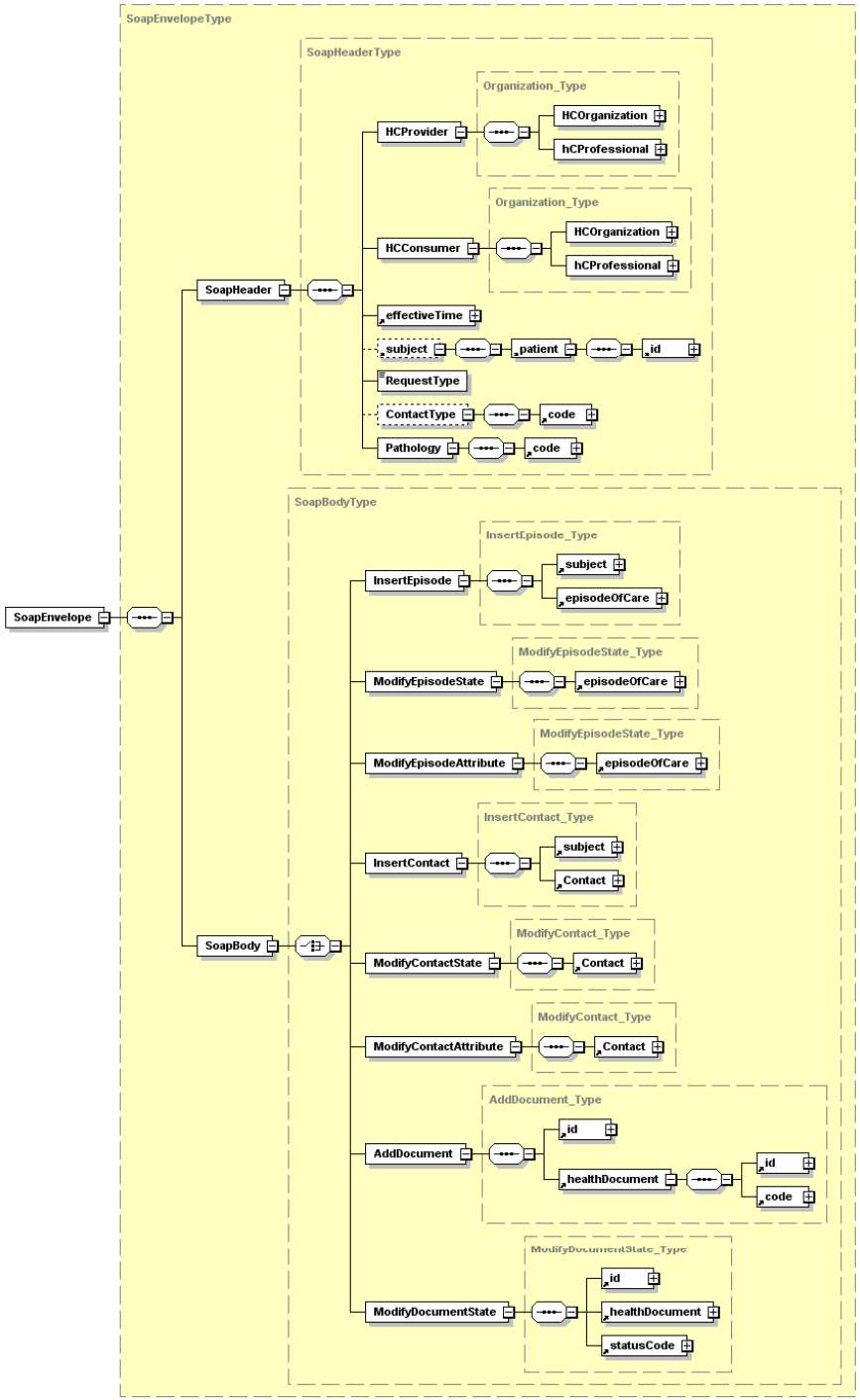
*) Health Level Seven International, *HL7 version 3*, http://www.hl7.org

HL7 Domain Analysis Model (DAM) for the LuMiR Healthcare Domain



Domain Message Information Model (D-MIM) of the Contact concept





HL7 generated message

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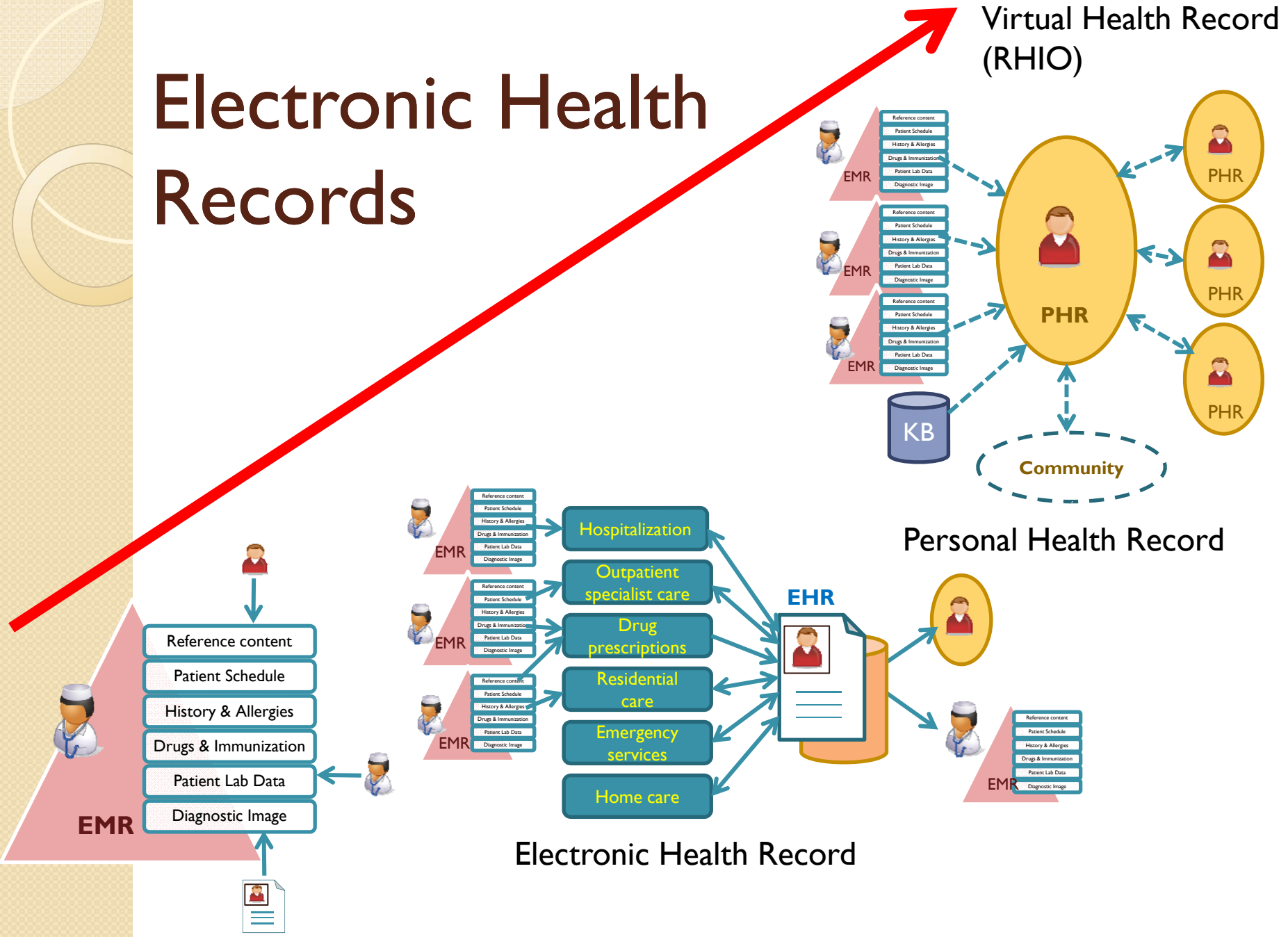
The “Interconnecting health” paradigm

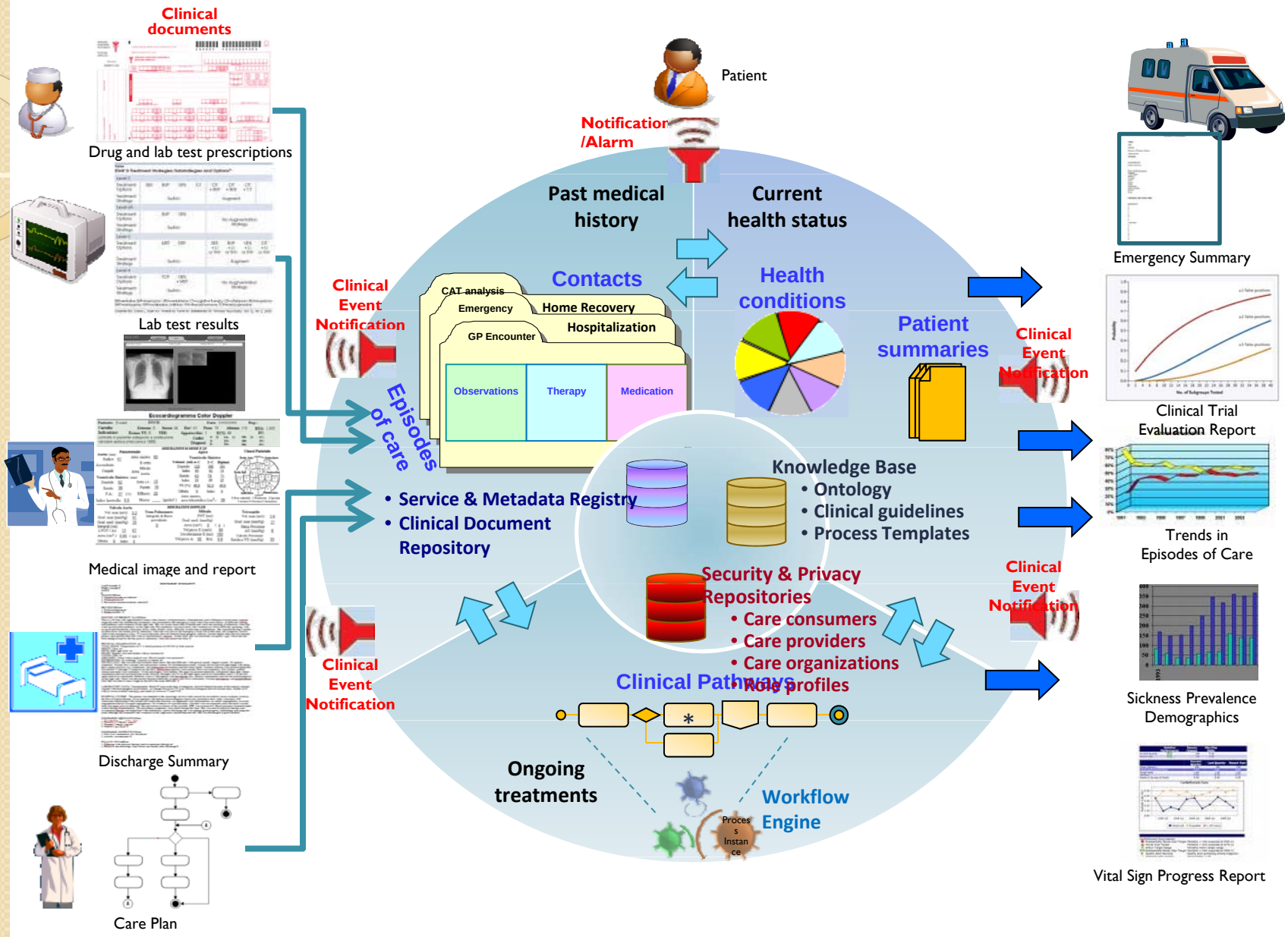
- Progress in IT has made possible the development of some new paradigms in health informatics.
- *Interconnecting health* focuses on the ability to connect health organizations and systems, and the role of IT as an enabler in achieving this connectivity.
  - The growth in importance of *electronic health records* in the last two decades marked a technological but also "cultural" shift.
  - The evolution of “Interconnecting health” was a continuous broadening of the horizon of interoperability in health.

Electronic Health Records



Regional Health Information Organization (RHIO)

Virtual Health Record*)



*) L.D.Serbanati, F.Ricci, G.Mercurio, A.Vasilateanu, Steps towards a digital health ecosystem, J Biomed Inform, Elsevier, 2011

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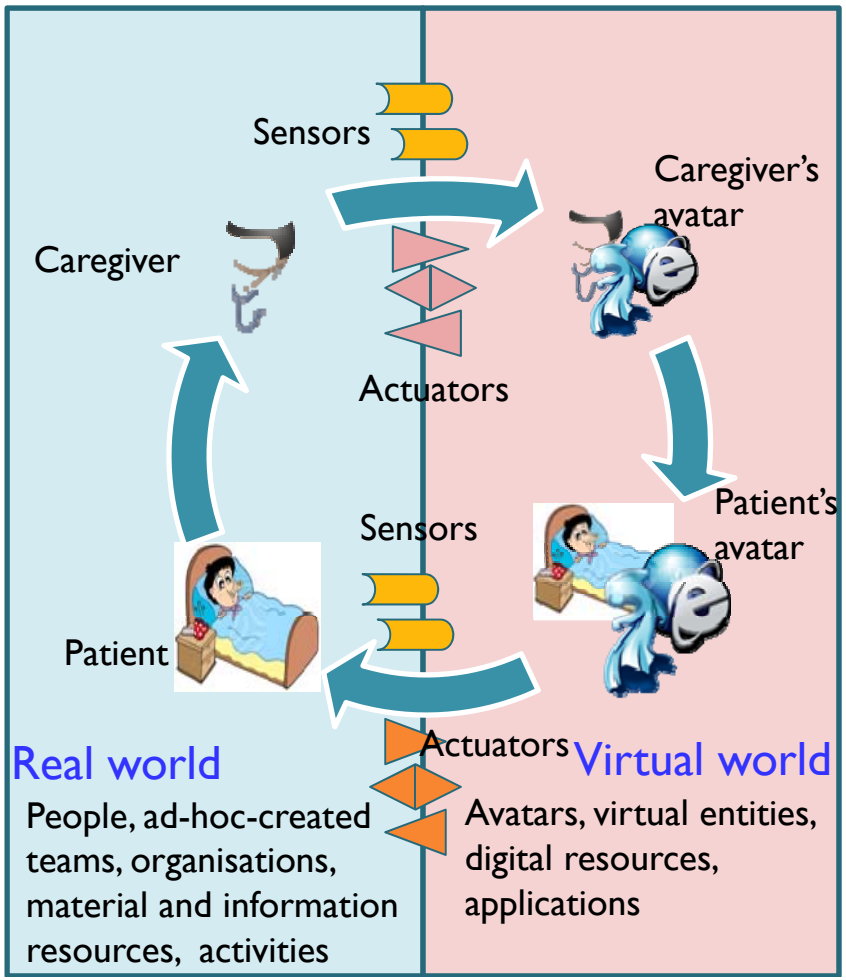
Multi-Agent System (MAS)

- The MAS paradigm could be used to model, design and implement software platforms that integrate software applications in healthcare systems.
- MASs are a more natural way to represent many situations that often occur in medical settings, such as:
  - absence of a comprehensive control system,
  - limited or insufficient resources for a care provider to solve a given problem, and
  - geographical distribution of the needed information and knowledge.
- On the other hand, in health systems we can identify many recurrent features common to MASs:
  - delegation of responsibility,
  - re-allocation of tasks,
  - need to consider a large variety of user concerns and problems,
  - planning the collaborative work ,
  - think and work in open spaces, etc.

R2V2R

Due to sensors and actuators, information flows from Real to Digital and from Digital to Real (R2V2R):

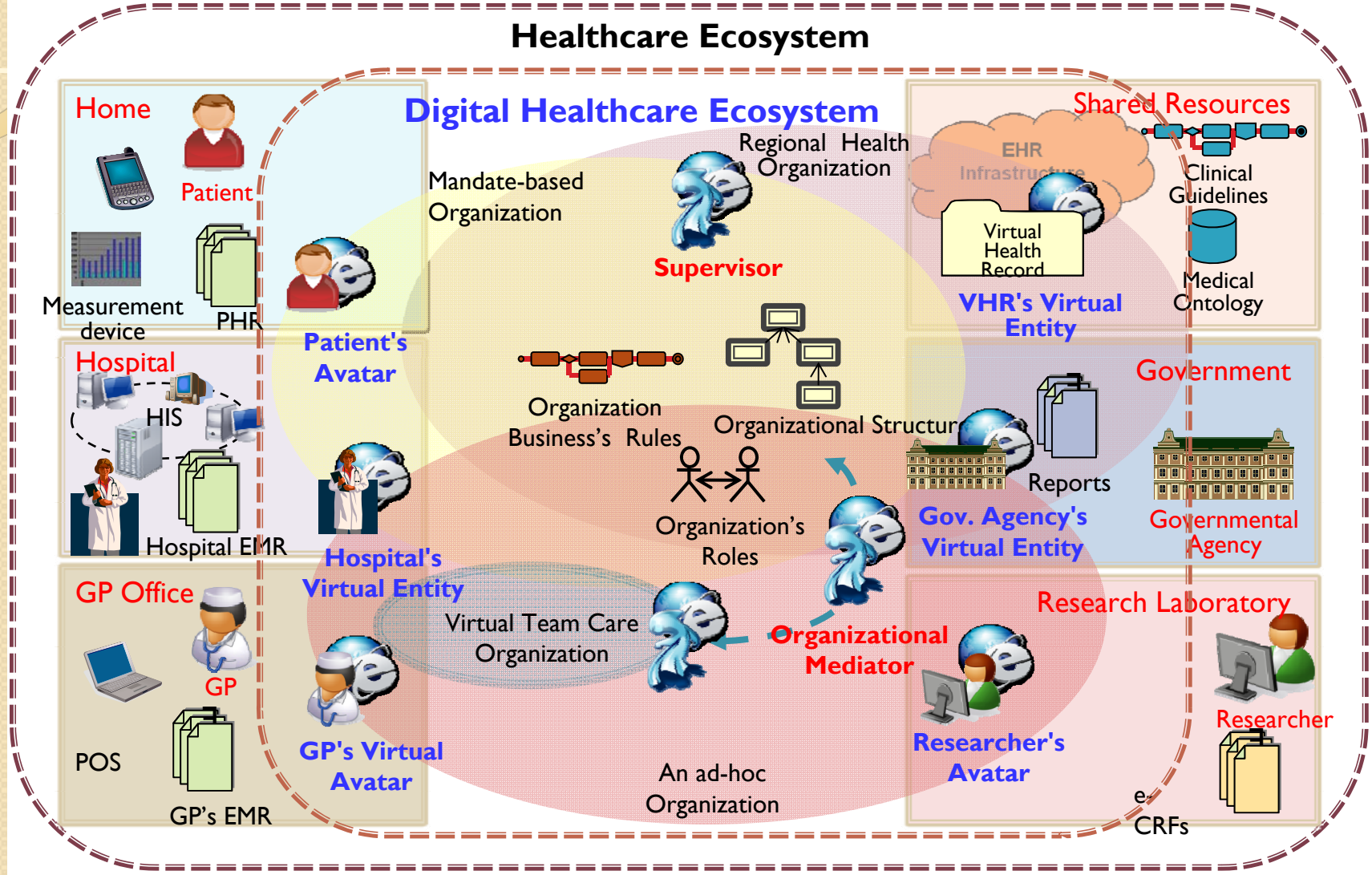


- In the case of "agentification" of a regional health information organization (RHIO), all stakeholders (care providers, professionals, patients and their relatives) from the real should be represented as *avatars*: highly proactive agents acting with own initiatives on behalf of an individual.
- Other *virtual entities* in the system may represent real organizations but also virtual, temporary, ad-hoc created organizations as teams of professionals involved in the patient's care process.

Ecosystem

- A *natural ecosystem* is a biological community of interacting organisms plus their physical environment.
- Correspondingly, a health ecosystem can be defined as a network consisting of a multitude of health service suppliers and consumers, and healthcare organizations, all of them supported by IT.
- *Digital business ecosystem* is a self-organising digital infrastructure aimed at creating a digital environment for networked organisations that supports the cooperation, the knowledge sharing, the development of open and adaptive technologies and evolutionary business models.
- *Digital health ecosystem* (DHE) is an IT infrastructure designed to work in synergy with the health ecosystem by mainly supporting health activities in the real world.

The health ecosystem and its digital ecosystem*)



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Conclusions

- This paper aims to open a discussion on the role of paradigms in our reasoning and proposes the use of innovative paradigm-based solutions in one or another field of activity.
- A paradigm better captures the nature of the differences between different approaches to solve a problem.
- Paradigm shifts in health informatics are good go-betweens in transferring knowledge to and from healthcare.

THANK YOU!

luca@serbanati.com

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