Software Adaptation to Dynamic Environment

For Seamless Ubiquitous Services

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IAM research group
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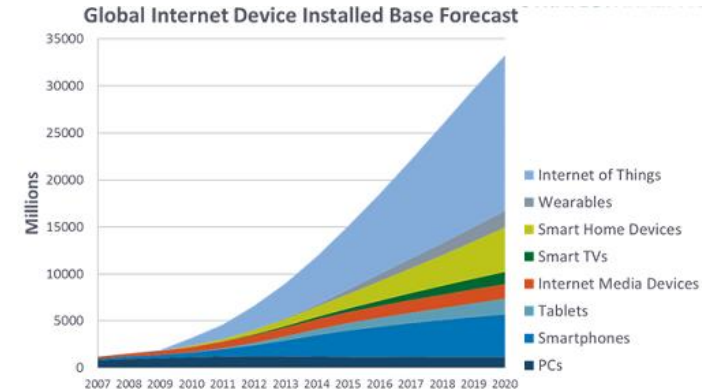
Ubiquitous Computing

« *Silicon-based information technology,*
is far from having become part of the environment »

Mark Weiser 1991

Technological Opportunities and Challenges

- New Smart Devices and Objects
  - New sensors, New actuators, New domestic robots, New Man Machine devices …
  - A **new kind of sotware infrastructure**

- Technological Software Interoperability
  - Over Internet connectivity
  - **Web Service oriented approach** for Smart Object and Device (Web of Things WoT and Devices)
  - With dynamic discovery, explicit API description, metadata …

- Lot of expectation for Seamless Ubiquitous Services in a physical connected world
  - **Lot of application domains** : Factory 4.0 and Assistive Activities for Workers on the field, Care and Assistive Living for elderly people…

Global Internet Device Installed Base Forecast

- Internet of Things
- Wearables
- Smart Home Devices
- Smart TVs
- Internet Media Devices
- Tablets
- Smartphones
- PCs

Source: Strategy Analytics, October 2014

Web Service of Device

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Seamless Ubiquitous Services in a **physical connected** world

- The right **services**

- Using the right **devices**

- In the right **contexts**

Illustration of our early results for Assistive activities of a mobile worker on the ground in Water Industry

Web Service
of Device

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Our hypothesis

- Multiple Software Applications sharing a same Software Services Infrastructure

- Dynamicity : Software Services are provided by Devices that are discovered at runtime and not always available

- Devices are interacting with a Physical World

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Our overall Research Approach

Multiple Applications are modeled with a Set of :

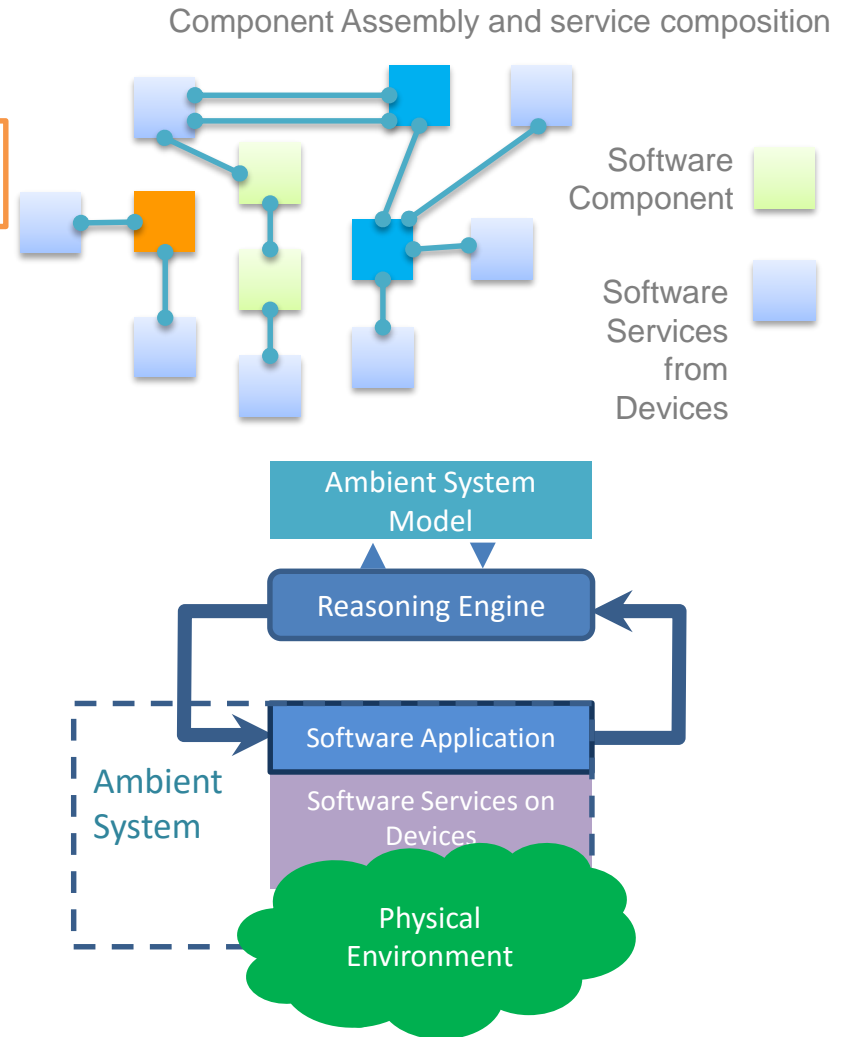R_i = (rules to select devices, rules to compose them)$_I$

- To produce relevant software applications as component assembly
- **Dynamically**

Our research is to find efficient Algorithms for Reasoning Engines for Dynamic Software Adaptation,
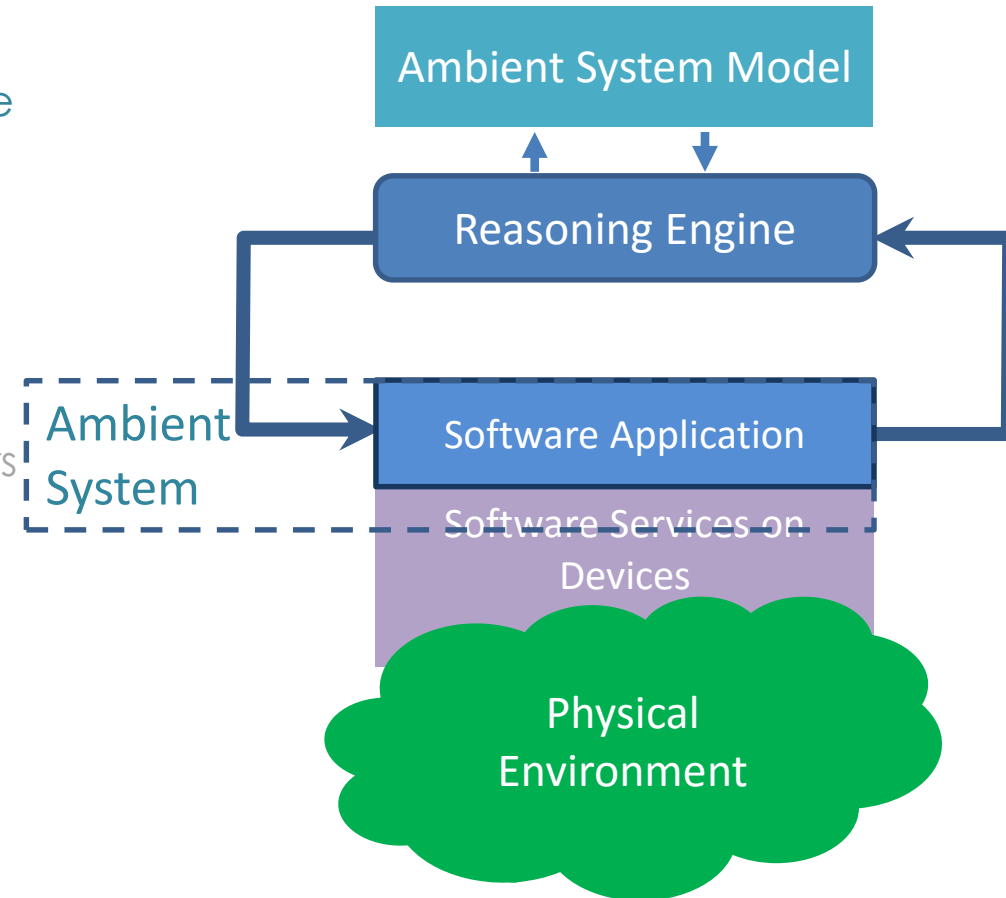
- *With logical properties*
- *With temporal properties*
- *With stochastic properties*

taking into account different Ambient System Model

Component Assembly and service composition

Software Component

Software Services from Devices

Ambient System Model

Reasoning Engine

Software Application

Software Services on Devices

Ambient System

Physical Environment
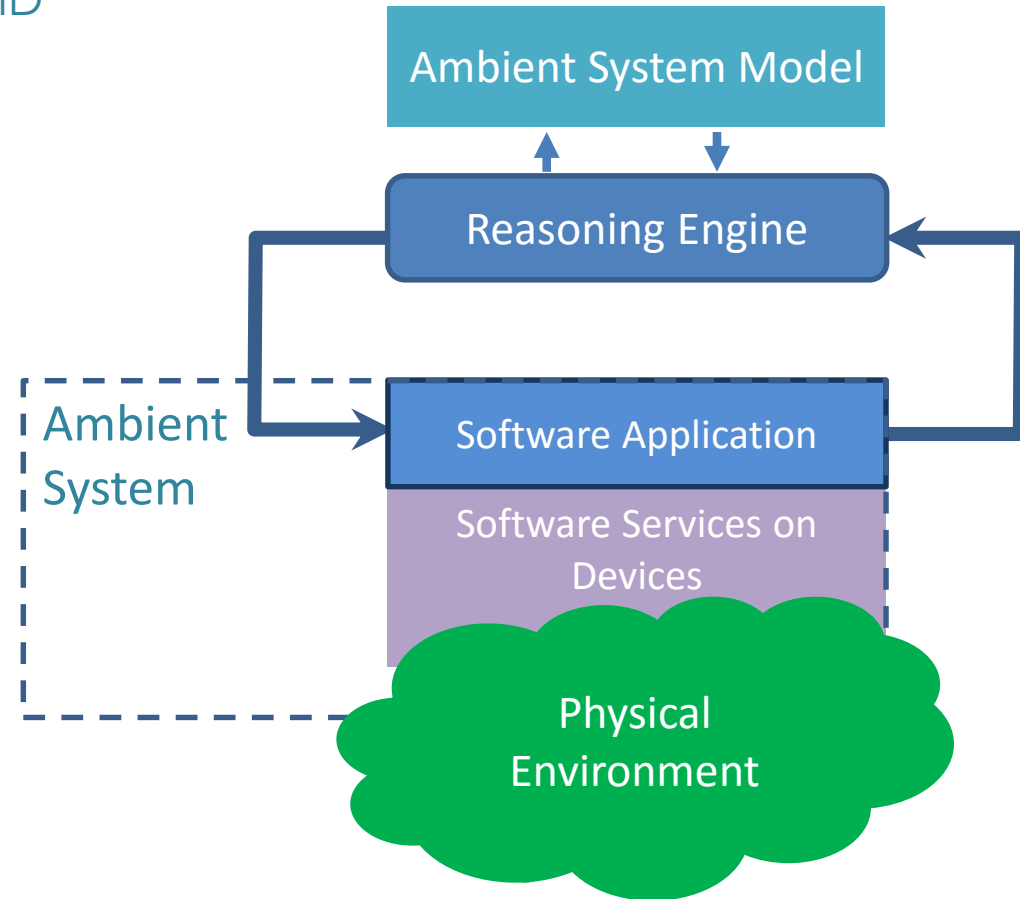
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Our researches and results

- Composition Algorithms and logical properties [PhD Sana Fatalah, Daniel Cheung]
- When Ambient System consists in software applications and a set of services
  - Historical Research (Cultural here)
  - Applications are component assemblies
  - Components correspond to operators in language
  - Merging algorithm between applications sharing services
  - This merging algorithm is maintening logical properties : symmetric composition

Ambient System Model

Reasoning Engine

Ambient System

Software Application

Software Services on Devices

Physical Environment
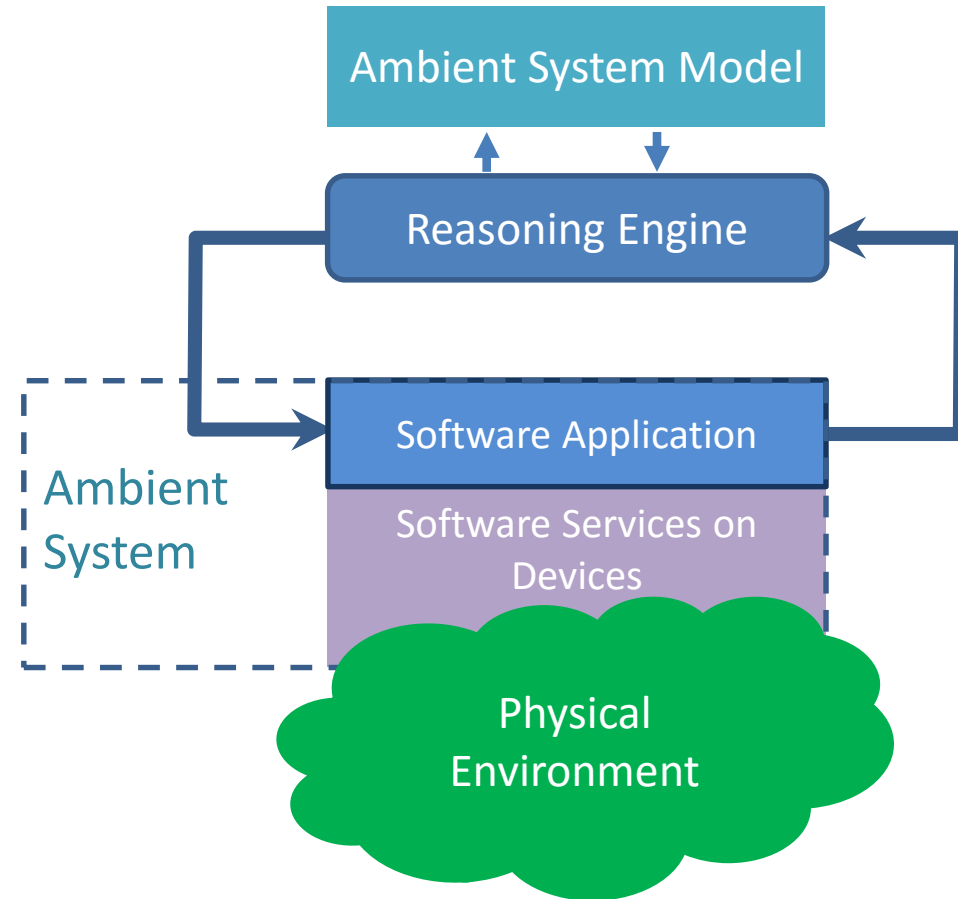
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Our researches and results

- Composition Algorithms and temporal properties in an adaptation loop [PhD Nicolas]

  - Multiple parameters analysis to anticipate temporal performances

  - Purpose : evaluate reactivity of the adaptation

- Composition Algorithms with Devices and local physical environment model

  - Synchronous Automaton model for **synchronous composition** with logical **constrains** [INRIA STARS Collab]

  - Simulation with DEVS formalism [with Univ Corse]

Ambient System Model

Reasoning Engine

Ambient System

Software Application

Software Services on Devices

Physical Environment

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One current research topics

- Semantic Selection of Services and Devices

  - With matadata

  - Based on heterogeneous semantics (heterogeneous ontology)
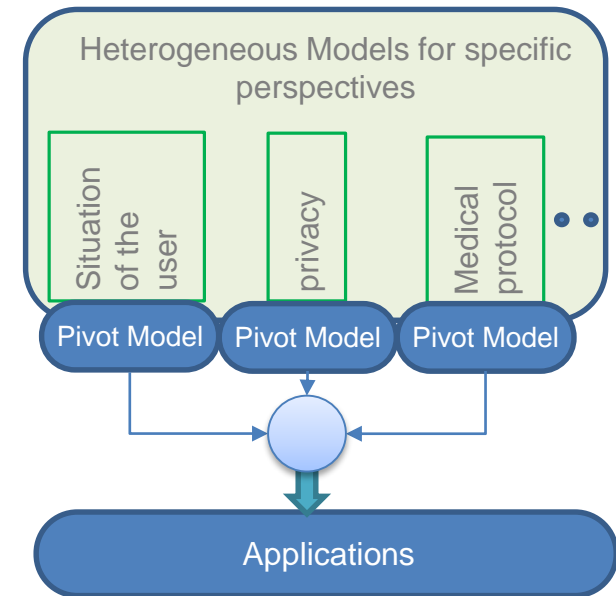
- Next Presentation G. Rocher

Ambient System Model

Reasoning Engine

Ambient System

Software Application

Software Services on Devices

Physical Environment

One current research topics

Context aware Approach
(Ph. D. Do The Can with G. Rey)

- Define theoretical models for the dynamic adaptation to the context
  - Consideration of an approach multi perspectives (multi-concerns)
  - Independence of perspectives

Heterogeneous Models for specific perspectives

Situation of the user | privacy | Medical protocol

Pivot Model | Pivot Model | Pivot Model

Applications

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One recent research topic

More recently, Stochastic properties when the applications interaction with a partly unknown Physical world (unbounded, only partly known …) (next presentation of G.Rocher)
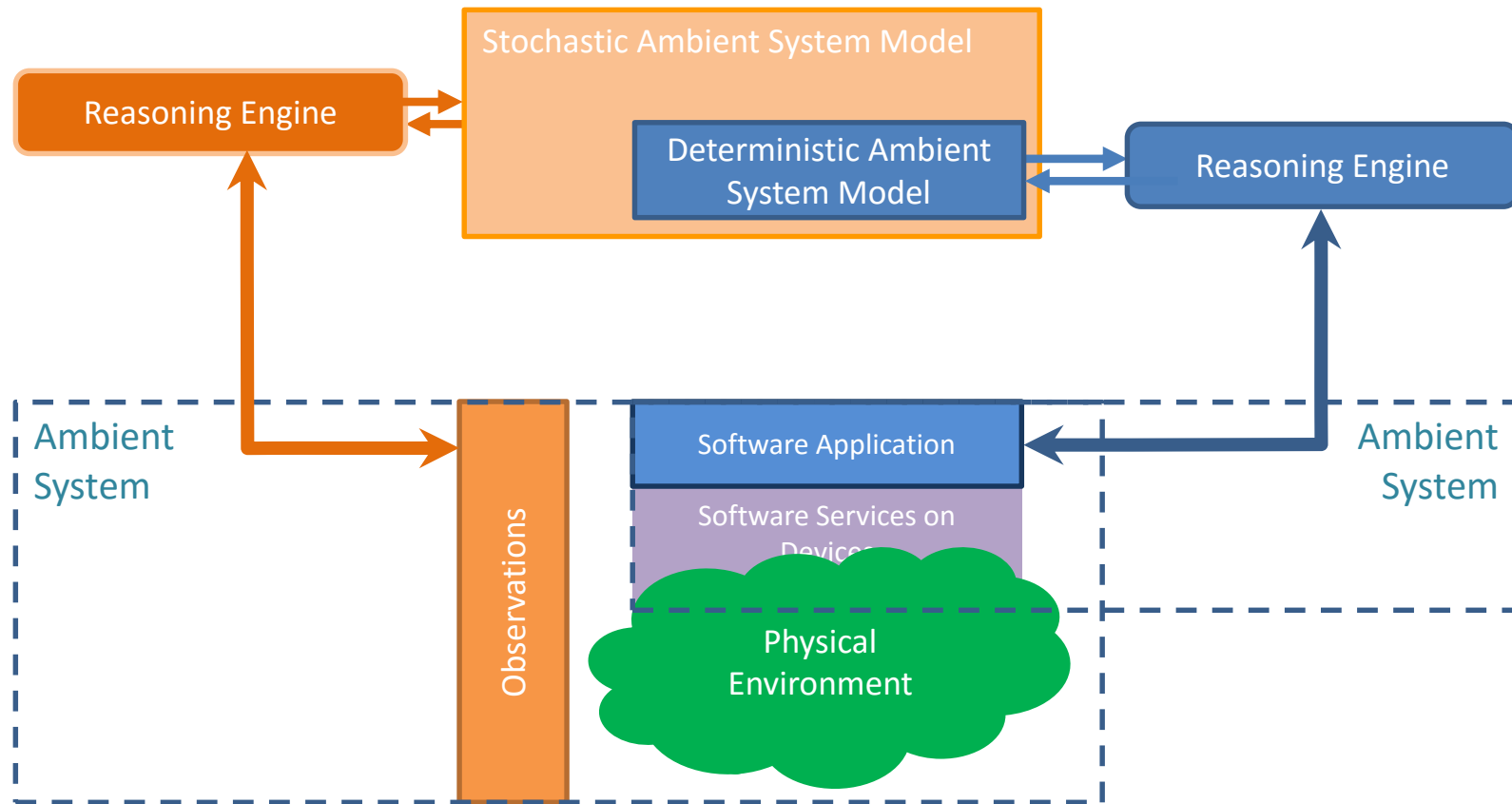
Projects and results
on that topic

- French projects on Seamless Ubiquitous Services

  - ANR Continuum : **CONTinuité de service en INformatique UbiqUitaire et Mobile**

- Research Project on Seamless Ubiquitous Services with Companies

  - U-INSITHER with and funded by EDF R&D : **Seamless Service for Mobile Agents**

- Research Project on Seamless Ubiquitous Services for Health care

  - With and funded by Berger Levrault : **Seamless Service for assisted living of elderly people at home**

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