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Ontological Goal Modelling for Proactive Assistive Living in Smart Environments

Joseph Rafferty, Liming Chen, Chris Nugent

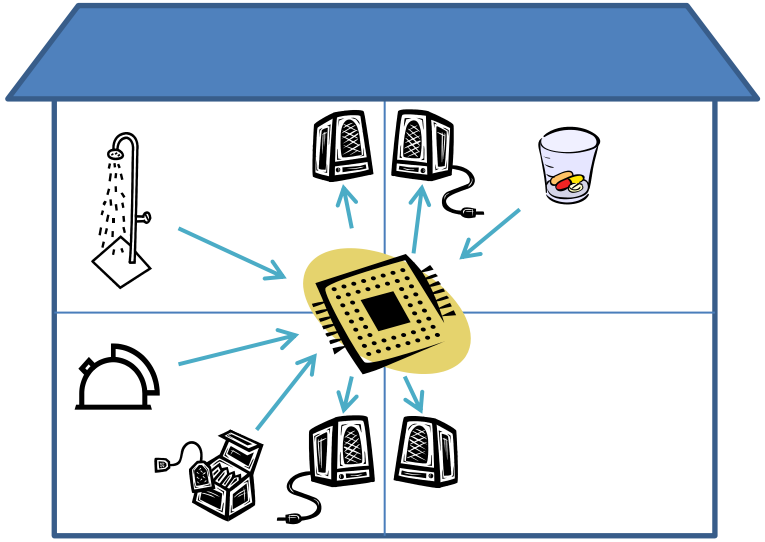
School of Computing and Mathematics
University of Ulster
Northern Ireland

Presentation overview

- Research problem
- Goal characterisation
- Ontological goal modelling
- Future work

What is a Smart Home?

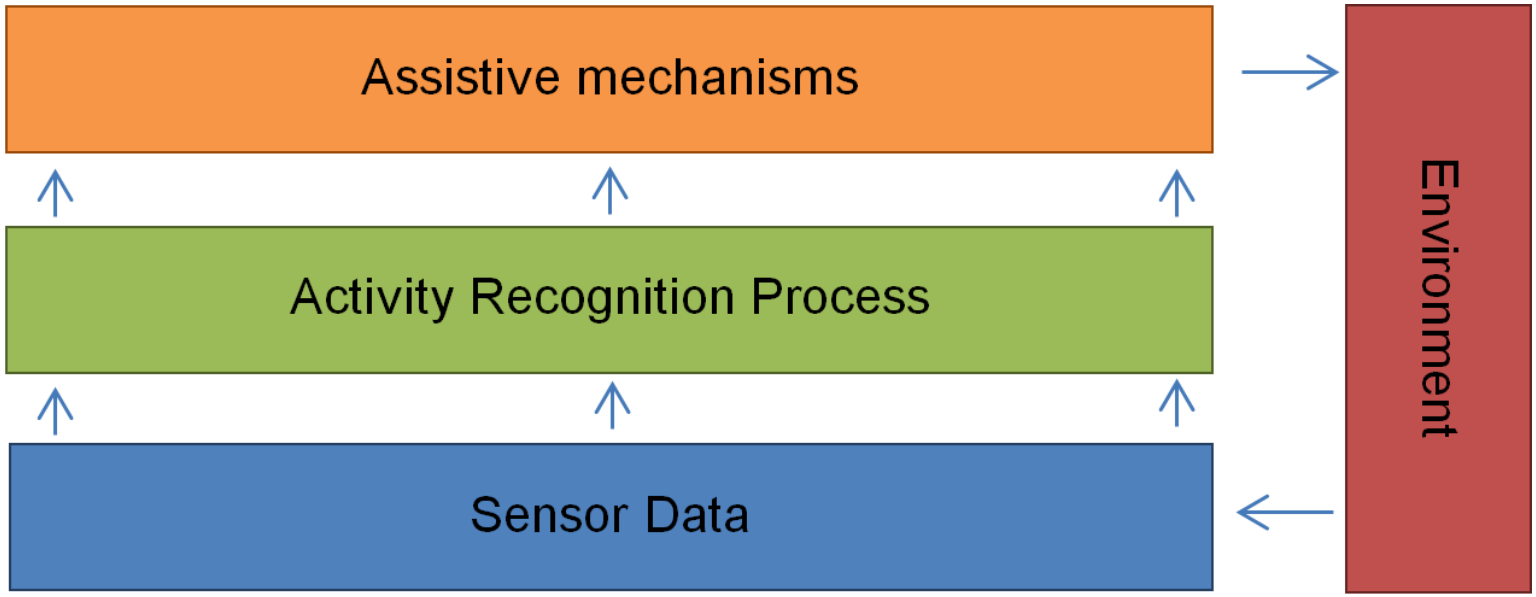
- Form of Ambient Assistive Living (AAL)
- Operating in a residential setting
- Most implement some form of activity recognition
- The main approaches to activity recognition are knowledge driven and data driven



Examples of current implementations

- Gatortech, an assistive living system based in University of Florida
- Mavhome, a smart home developed by Washington state University and the University of Texas at Arlington
- iDorm based in the university of Essex
- Alz-Mas, an assistive care system at the University of Salamanca

Current Bottom-up Approach to AAL

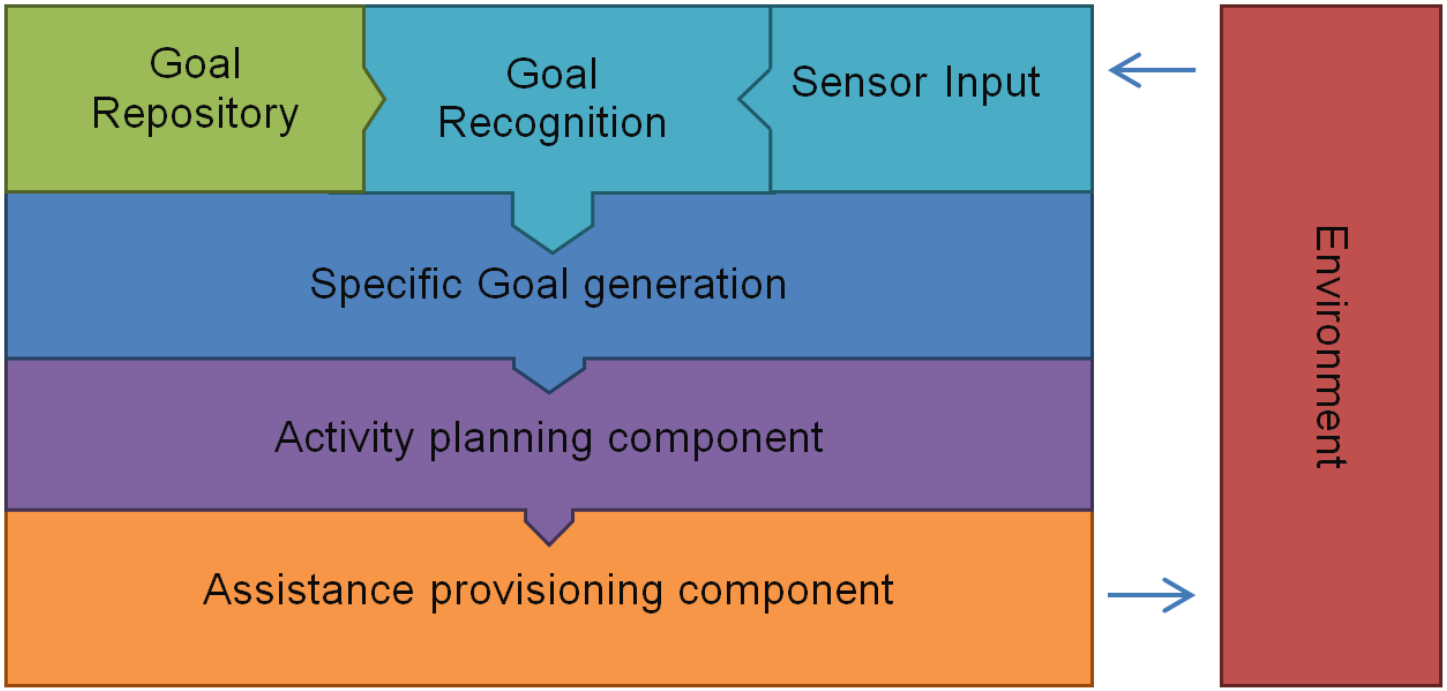


- Disadvantages with sensor density, privacy concerns and dealing with variation in activity performance (Poland *et al.*, 2009)
- Provides reactive assistance (Chen *et al.*, 2012)

Smart Home Issues

- Sensor Density - To operate efficiently a large number of sensors need to be placed in an environment or on object inhabitants interact with
- Inhabitant privacy – Privacy can be violated in smart homes where a record of inhabitant activity is to be used as a reference for activity recognition
- Variation in activity performance – Activities are generally not modelled a way which allows flexible performance to be recognized
- Reusability – Certain smart home implementations are tied to specific environments and their scope of use is limited

Proposed Goal-Driven Approach to AAL



- Key elements
  - Flexible Goal Models
  - Goal Recognition
  - Activity planning
  - Proactive Illustrative Assistance

Intelligent Agents in AAL

- Intelligent agents are software entities which operate to achieve a desired world state
- Most popular realisation of intelligent agents is the Belief-Desire-Intention architecture, based on cognitive models
  - Beliefs represent a world as perceived by an agent, Desires provide motivation for agents, Intentions are actions an agent has committed to
- Agents have been previously used to realise AAL systems
  - These systems, when using activity recognition, generally follow the bottom-up approach
  - Currently these agents focus on pursuing ***system*** desires
- Agents are suited to realising a goal-driven approach to AAL, by
  - Perceiving an inhabitants environment
  - Modelling and detecting ***inhabitant*** goals
  - Using effectors to direct inhabitants to goal completion, when necessary

Goal Modelling in Intelligent Agents

- Goal definition: A goal is a desired situation that an intelligent agent or actor has committed to actively pursuing

- In order to effectively model goals two aspects must be represented
  - Procedural: action plans that can be followed to complete the goal
  - Declarative: a meta-representation of a goal providing the basis for deliberation on goals and their lifecycle stages
  - Both aspects need to be modelled to suitably represent inhabitant goals
- Some current agent systems model goals with both these aspects
  - Designed to model the goals and lifecycles of a software agent
  - Not suited to modelling inhabitant goals

Base Goal Type

- Goal Metadata
  - Name
  - Description
  - Operational State – The current operational state of the goal (determined by encountered conditions) [{Inactive},{Active},{Assist},{Suspended}]
  - Previous event timestamp – A unixtime representation of the previously observed action
- Conditions
  - Precondition – When a goal is likely being considered by an inhabitant
  - Suspend Condition – When an inhabitants pursuit of a goal is suspended
  - Assist Condition – When assistance is offered to an inhabitant
- Other goal types
  - Achieve Goal – An inhabitant goal that can be achieved (e.g making tea)
  - Maintain Goal – An inhabitant goal that needs to be maintained (e.g. regularly taking medication to control insulin)

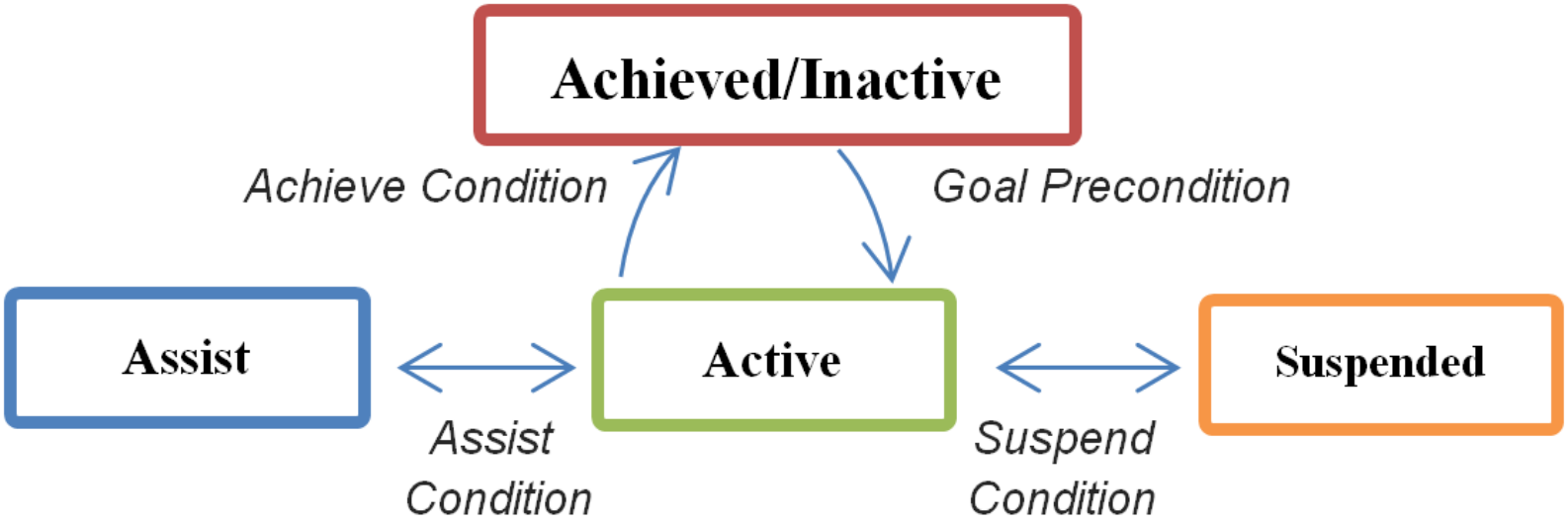
Specialized Goal Types

- Achieve Goal
  - Achievement Condition – The condition when the goal is considered to be achieved
- Maintain Goal
  - Target Condition – The condition to be maintained (e.g. a specific ambient temperature)
  - Trigger Condition – the condition which specifies when the maintain condition should be pursued (e.g. the ambient temperature goes beyond a specific range)
  - Maintenance Check Frequency – How often (in seconds) the trigger conditions of the maintain goal is checked

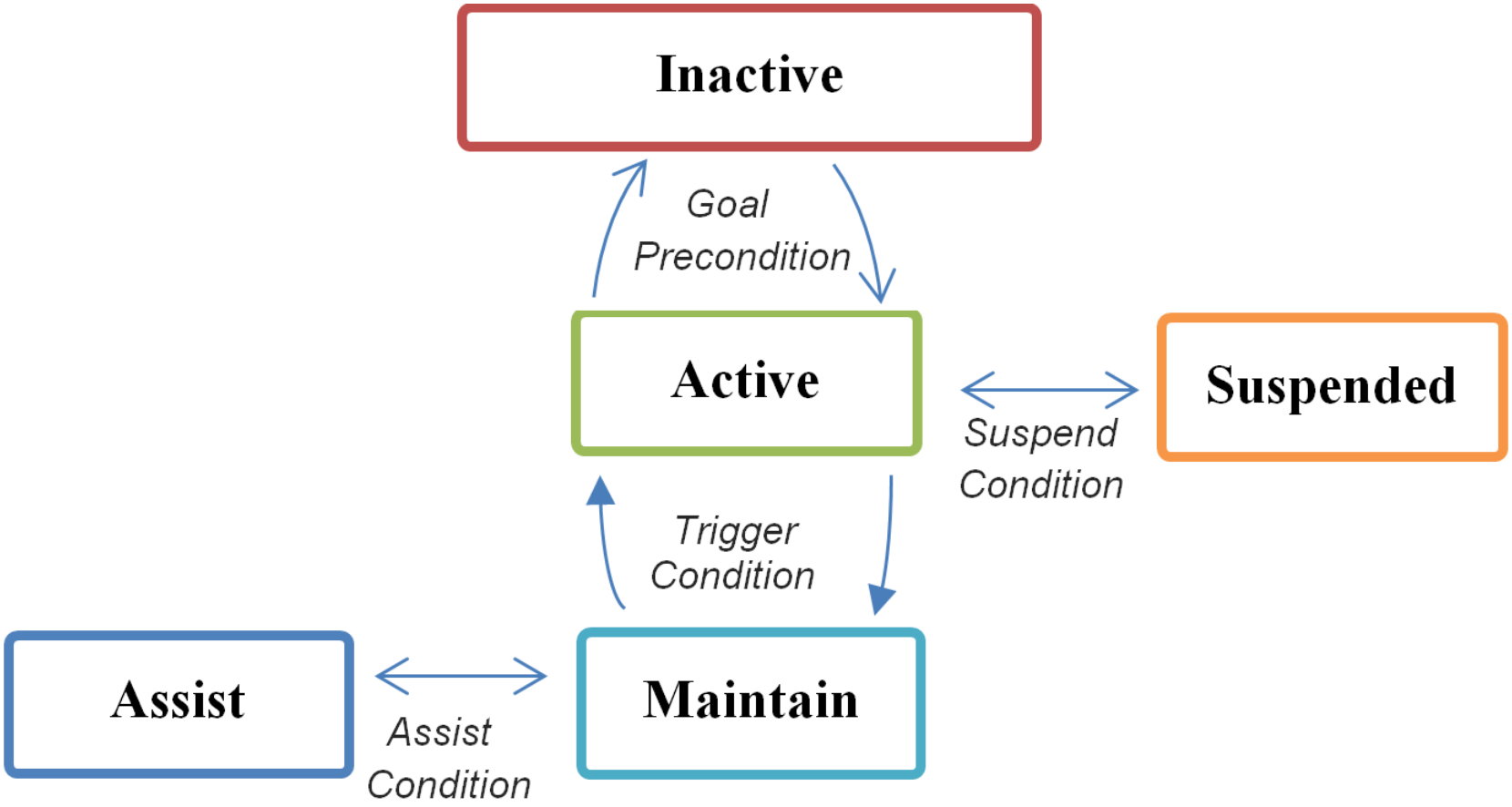
Goal Action Plan

- Goals require a procedural aspect to represent steps to achievement, an action plan consisting of atomic actions
- Action plan properties
  - Name
  - Description
- Atomic action properties
  - Name
  - Precondition- a precondition needed for this action to be eligible
  - Effect – how the action is enacted
  - Status – the status of an action [{Complete},{Incomplete}]

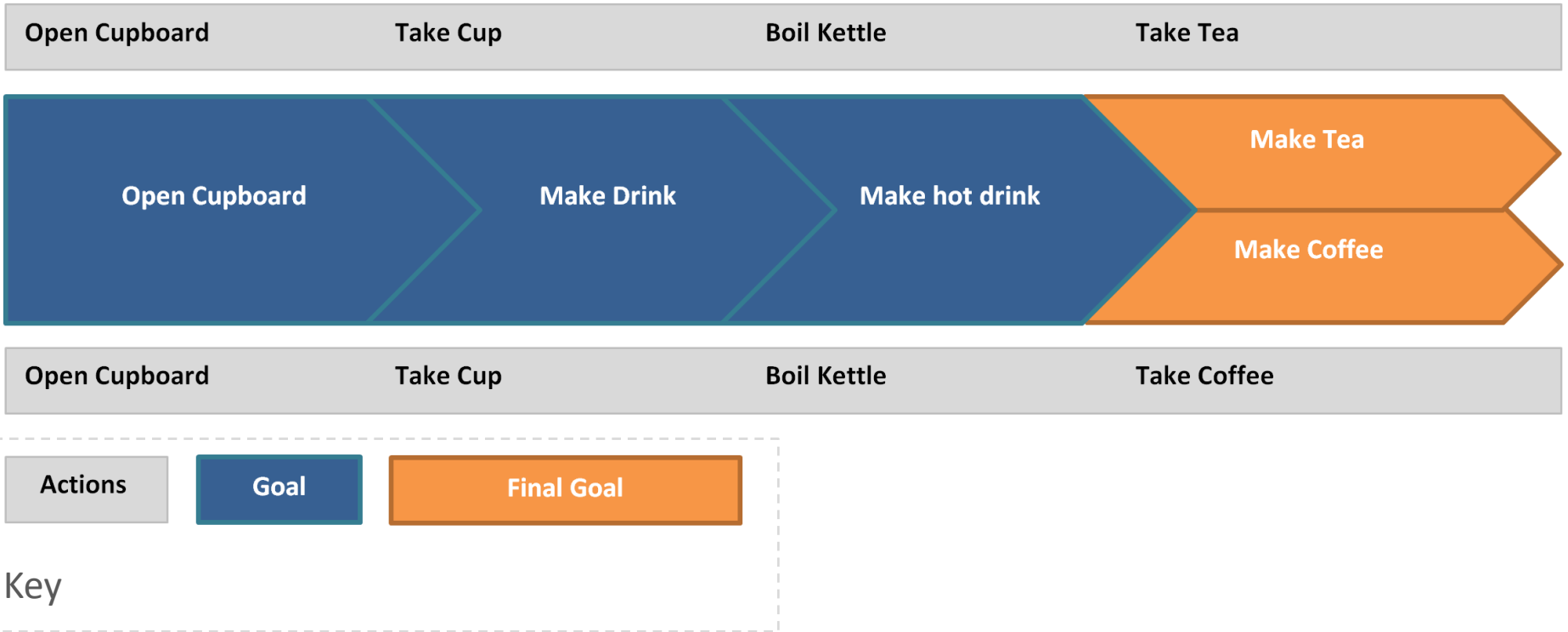
Goal Lifecycle - Achieve Goal



Goal Lifecycle – Maintain Goal



Nested subgoals



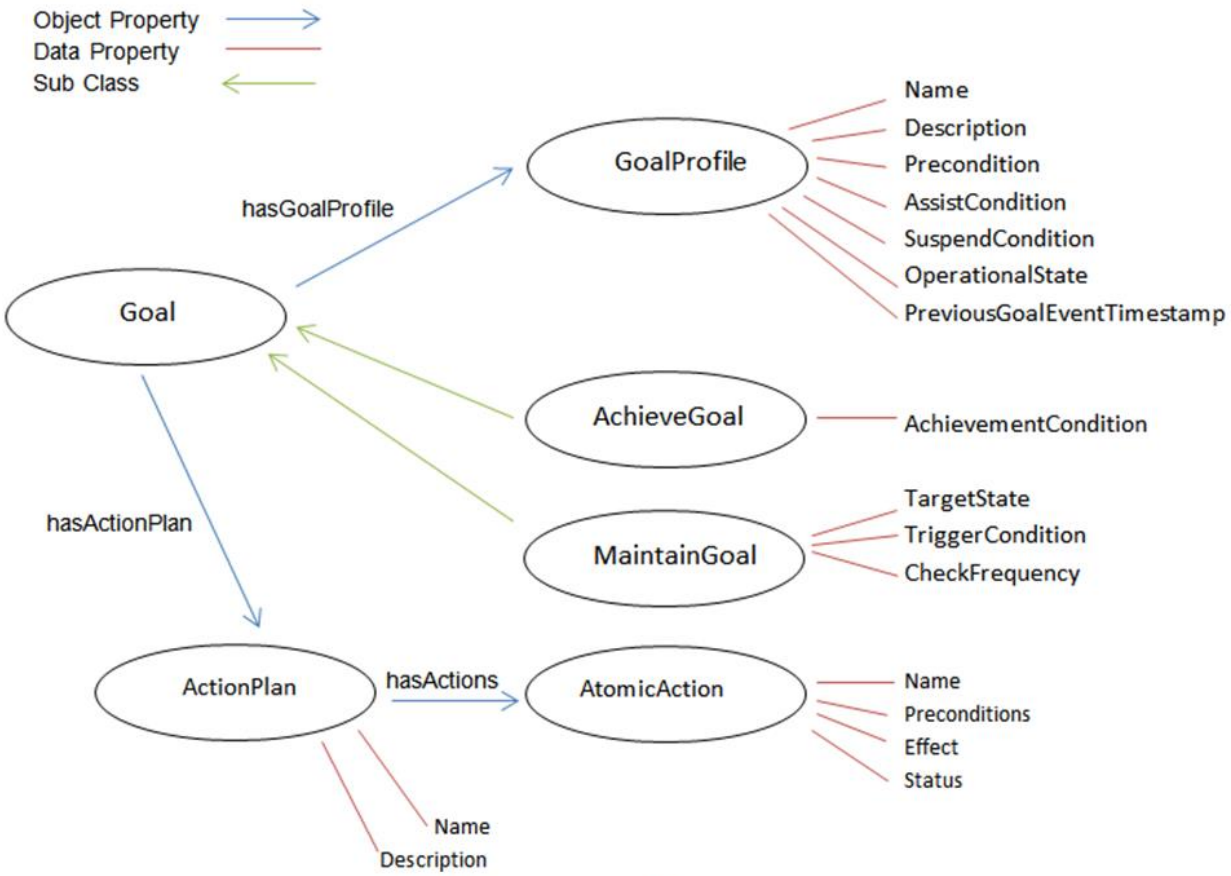
- Goals may have goals as preconditions resulting in subgoals
- Provides an avenue for more flexible activity modeling

Goal conceptual modelling

- To model inhabitant goals the properties, goal types and conditions to be encountered were considered (as covered)

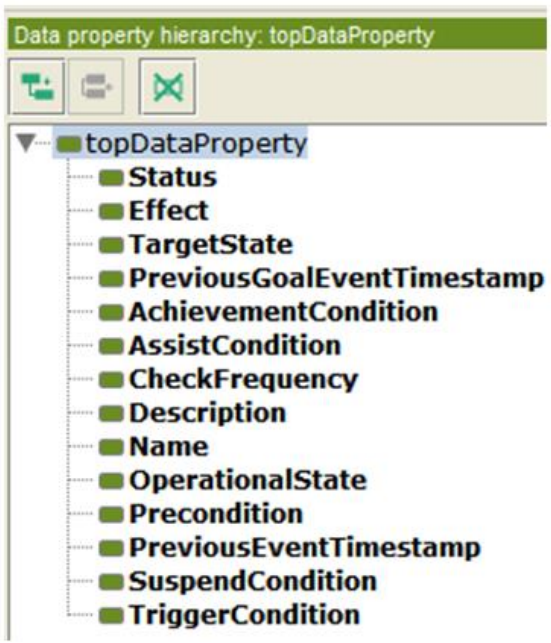
- Types of goals that an inhabitant would pursue (achieve, maintain)
- When a goal would be pursued
- When assistance is to be provided
- Conditions for the general lifecycle of a goal
- Declarative aspects to allow deliberation
- Procedural aspects detailing steps for goal pursuit
- Elements for state tracking and lifecycle transition

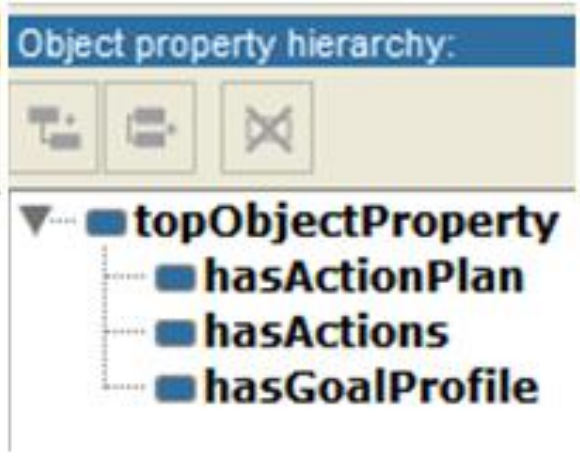
Ontological Goal Model



Ontological goal modelling

Ontological Goal Model





Place within the PIA project

- This work will have aspects that can be integrated into the EU AAL PIA project
- PIA will operate a video playback service based on smartphone/tablet interaction with NFC tags. This can be modified to produce a goal driven approach to AAL
- Inhabitant goals can be extended to model the intended goal of an inhabitant of the PIA system
- Goals in need of assistance can be combined with activity planning to determine the steps needed to complete the task
- Video clips used by PIA can be profiled to be used as activity fragments to allow creation of composite video sequences

http://www.pia-project.org/

Future Work

Complete all remaining components, namely:

- Goal recognition – to determine possible intended inhabitant goals
- Specific goal generation – to nominate intended goals for assistance and manage lifecycles
- Activity Planning – to determine steps (activity plans) needed to complete a nominated goal
- Assistance provisioning – to use the activity plans an annotated video clips to provide assistance to inhabitants
- Testing and evaluation

Thank you

Any Questions??

Rafferty-j@email.ulster.ac.uk