Honeywell

Independent LifeStyle Assistant™ (I.L.S.A.)

A NIST ATP Program

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i.L.S.A.

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In a Nutshell

Program Objective

Develop an intelligent home automation system with situation awareness and decision-making capability based on integration of diverse sensors, devices, and appliances to support caregivers and enable elderly users to live independently at home.

Programmatics:

- A NIST Advanced Technology Program
  - » 2.5 years (Nov í00 ñ Mar í03)
  - » $5.3 Million
- Lead by Honeywell
  - » Behavioral Informatics, Inc.
  - » SIFT, LLC
  - » United Health Group EverCare
  - » University of Minnesota School of Nursing

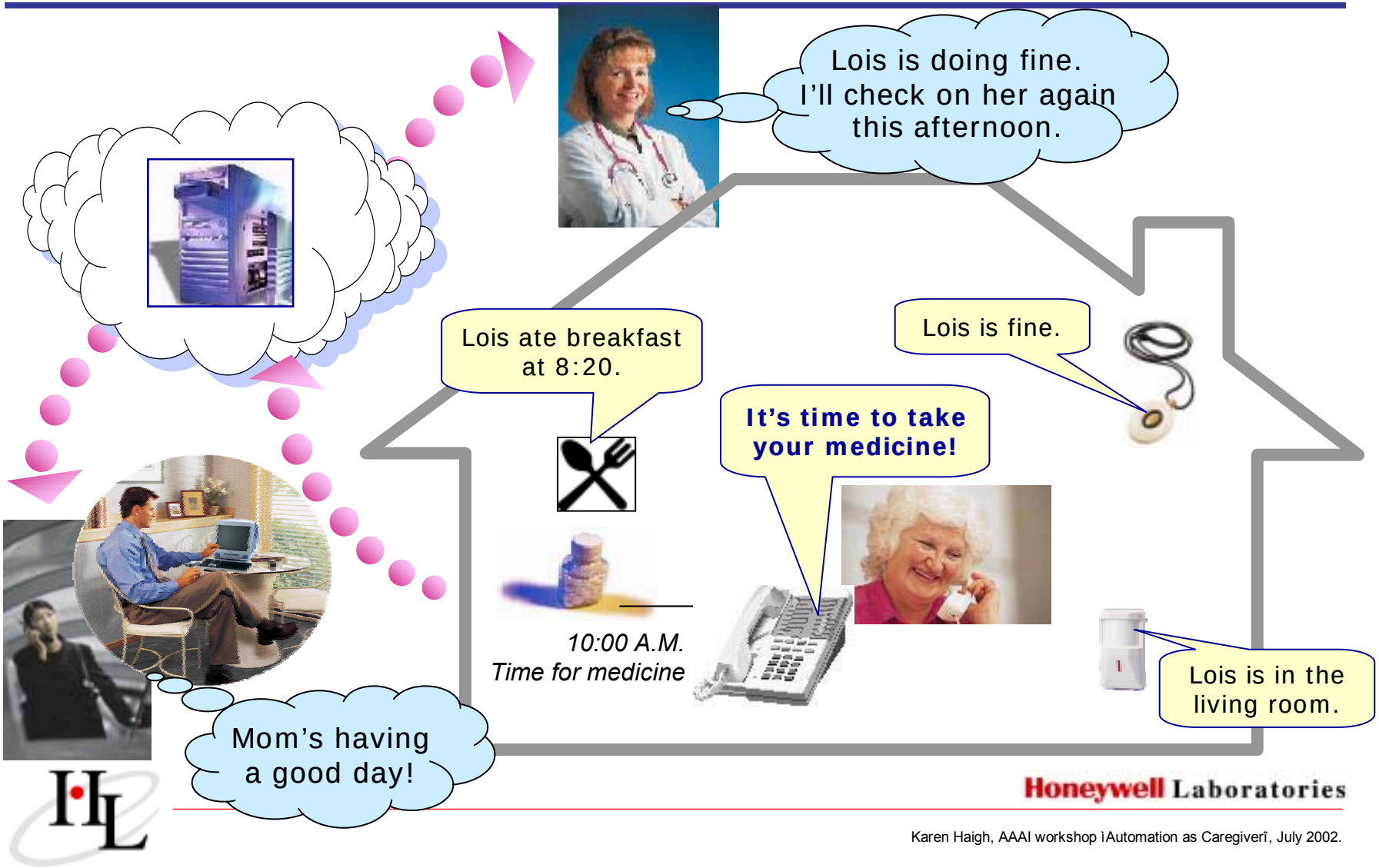
Benefits:

- Support elder independent living
- Provide peace of mind to caregivers
- Support efficient quality care for caregiving organizations
- Cost savings for government and industry
- Market growth for in-home product producers

The Vision

- Gather information about elder, activity, and home status by listening to the home and communicating with devices
- Assess the need for assistance based on the systemís understanding the elderís condition and what activities are going on inside the home
- Respond to a given situation by providing assistance to the elder and getting help when necessary
- Share health and status information with authorized caregivers to help improve the quality and timely delivery of care

The Vision



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Finding Relevant Features

Factors contributing to institutionalization

- caregiver burnout
- medication mgmt, medical monitoring
- mobility, wandering, toileting, dementia, safety
- usability

Technological feasibility & match

- demonstrable in 30 months
- fits I.L.S.A. vision of passive monitoring & support

Initial Feature Set

Monitoring Functions

- Mobility (general activity level)
- Verify medication taken
- Panic button activation
- Toileting
- Eating
- Environment (comfort/intrusion)

Response Functions

- Alarms
- Alerts
- Notifications
- Activity Reports

Service Features

- Reminders
- Internet & phone access to elder activity
- Caregiver to-do lists
- Coordinate multiple caregivers

Usability Features

- Password-free elder interactions
- Operational modes
- Queries to elders
- Feature Controls

User Interfaces

- Elder: Phone, webpad, eFrame
- Caregiver: Web, phone, email

Software Architecture Requirements

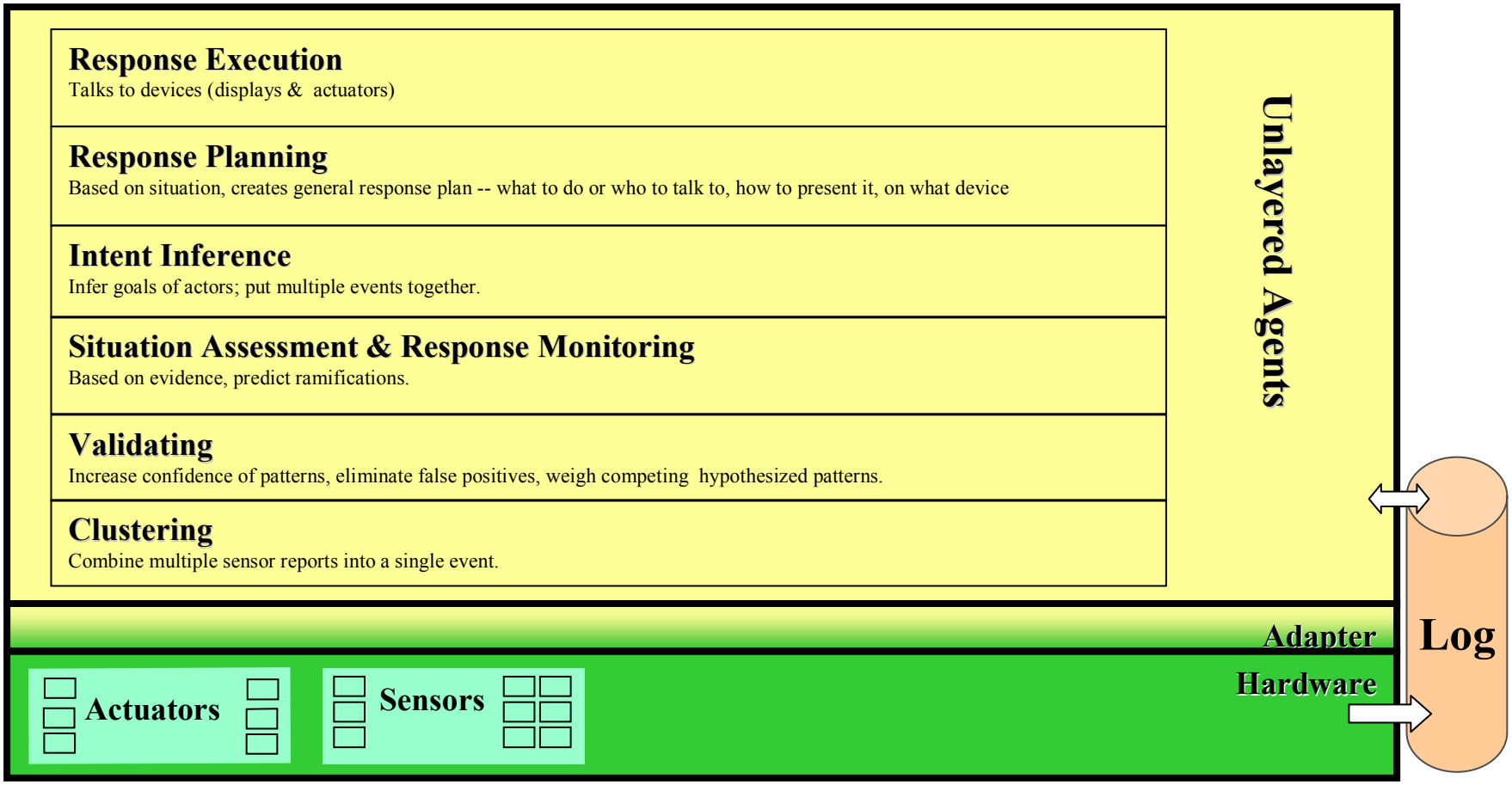
Each ILSA client and home will be very different and have specialized needs, so the system must be:

- rapidly deployable,
- easily configurable,
- highly modular, and
- adaptive to the environment.

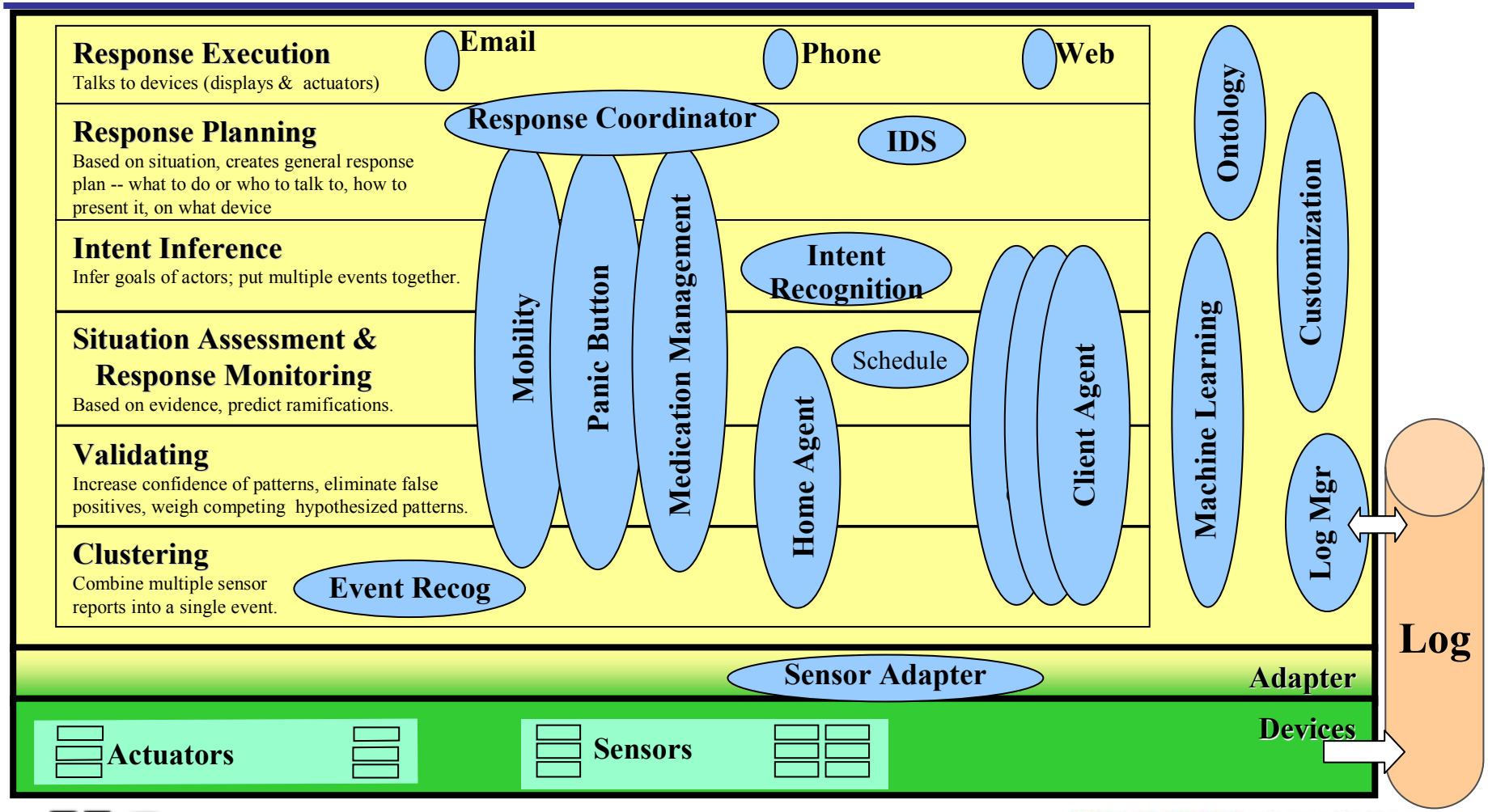
Modularity is critical both to functionality as well as expandability for a number of reasons:

- Integrate 3rd party functional units
- Flexibility of sensor and actuator suites
- Expansion of ILSA capabilities over time

Layered Agents



Agents


Response Execution
Talks to devices (displays & actuators)
Email
Phone
Web
Response Planning
Based on situation, creates general response plan -- what to do or who to talk to, how to present it, on what device
Response Coordinator
IDS
Intent Inference
Infer goals of actors; put multiple events together.
Intent Recognition
Situation Assessment & Response Monitoring
Based on evidence, predict ramifications.
Schedule
Validating
Increase confidence of patterns, eliminate false positives, weigh competing hypothesized patterns.
Clustering
Combine multiple sensor reports into a single event.
Event Recog
Mobility
Panic Button
Medication Management
Home Agent
Client Agent
Ontology
Customization
Machine Learning
Log Mgr
Log
Sensor Adapter
Adapter
Actuators
Sensors
Devices

ILSA Agents

Agents group functionality, e.g.

- Mobility monitor
- Medication monitor
- Client interaction module
- Device controllers

Agents group technical capability, e.g.

- Machine Learning
- Task tracking
- Response Planning

Device Agents

Intelligent, coordinated integration of multiple sensors, effectors and and displays

- Use standard communication protocols and the Ontology to seamlessly incorporate new devices
  - » sensing into the situation-aware infrastructure
  - » actuation / displays from response planner
- Cluster information from low cost, fault-vulnerable devices of disparate types to provide information about the clientís behaviour

Task Tracking

Recognize what the client is doing:

- Considers all hypotheses and actively reweights them as new evidence is added
- Can recognize that one sensor sequence may mean two different things (competing possibilities),
- Be aware of how confident it is in the recognized sequence (e.g. competing possibilities, or noisy sensors),
- Handle missed actions (e.g. when a sensor failed)
- Recognize what the person was TRYING to do, even if they didn't actually succeed or have not yet completed the task

Domain Agents

For each user function:

- Assess the situation
  - » Current state of world (devices and actors)
- Provide plan libraries for task tracking
  - » Models of client activities that are of interest
- Propose response
  - » *What*: gather more evidence, interact
  - » *Who:* which type of devices (house, external) or which people (client, caregiver)
  - » *When:* degree of intrusiveness (severity) (AARN)

Response Coordination

Given a set of proposed interactions

- whom/what to contact, severity
- generated from many *independent* domain agents

coordinate responses without overloading resources (device or human)

- *where*: location of devices (actuator or display)
- *how*: presentation format (adaptive interfaces)
- e.g.: do not issue reminders when in alarm state

Machine Learning

Learn models of the actors and environment to automatically improve the performance of the system:

- what is normal / unusual, for elder, caregiver and other environmental factors
- what is the most effective technique to use
- understand sensor reliability
- etc

Domain agent example: Medication

- Situation assessment from sensor events
- Asks Task Tracker for client intent
- Requests alerts and notifications for anomalous events
- Reminds according to schedule and recent activity
- Uses machine learning to adjust schedule, and likely task performance

Domain Ontology

A common vocabulary that lets agents communicate with precision about the world

It provides standard interpretations for words

- that might otherwise be dangerously ambiguous

It structures the domain knowledge in ways that allow it to be analyzed,

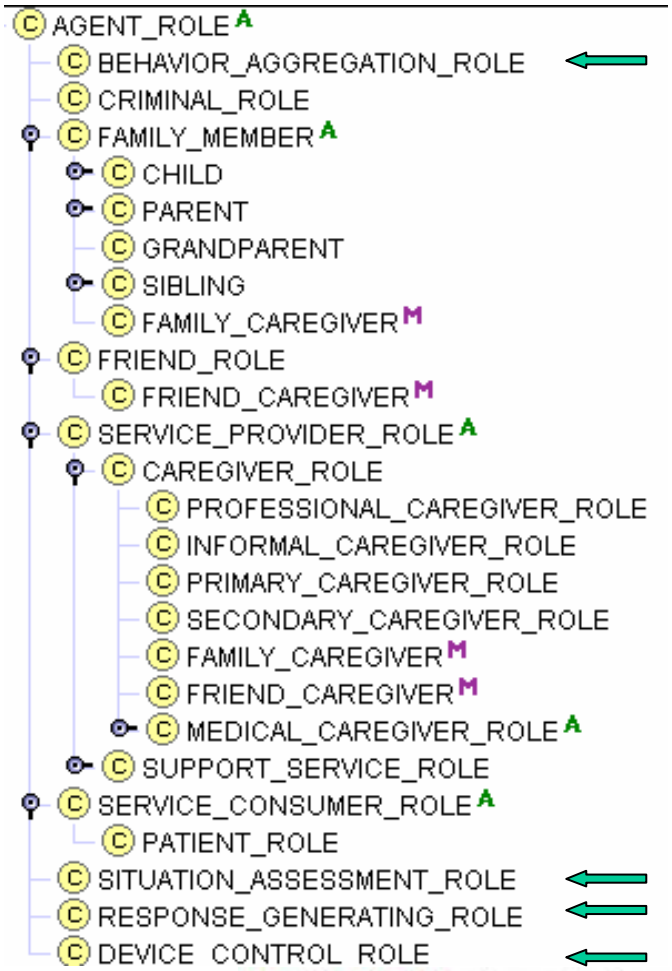
- making assumptions more explicit

Currently undergoing review with 3rd parties

Domain Ontology (II)

1000 classes, in hierarchy, top levels include:

AGENT
AGENT_ROLE
COMMUNICATION_ACT
PHYSICAL_OBJECT
MEASURABLE_ATTRIBUTE_TYPE
PLACE
PREDICATE
PROCESS
RELATION_TYPE
TEMPORAL_OBJECT



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Field Tests

Installations for 20 elders, mix of

- independent homes
- independent elders in communal living facilities

Hardware installed August 2002

I.L.S.A. tests running Sept - December

Publications

Christopher W. Geib and Robert P. Goldman, 2001. "**Probabilistic Plan Recognition for Hostile Agents**,î Proceedings of the FLAIRS 2001 Conference, October 2001. Pages 580-584.

Several papers to appear at AAAI-02 Workshop on ìAutomation as Caregiver,î July 2002.

K. Z. Haigh, J. Phelps and C. W. Geib, 2002. "**An Open Agent Architecture for Assisting Elder Independence**," AAMAS July 2002.