

Concept and Design of an AAL Home Monitoring System based on a Personal Assistive Unit

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- The Kaiserslautern *Ambient Assisted Living (AAL) Project*
- Introduction to PAUL
- The Automata Engine
- Summary and Outlook

Objectives

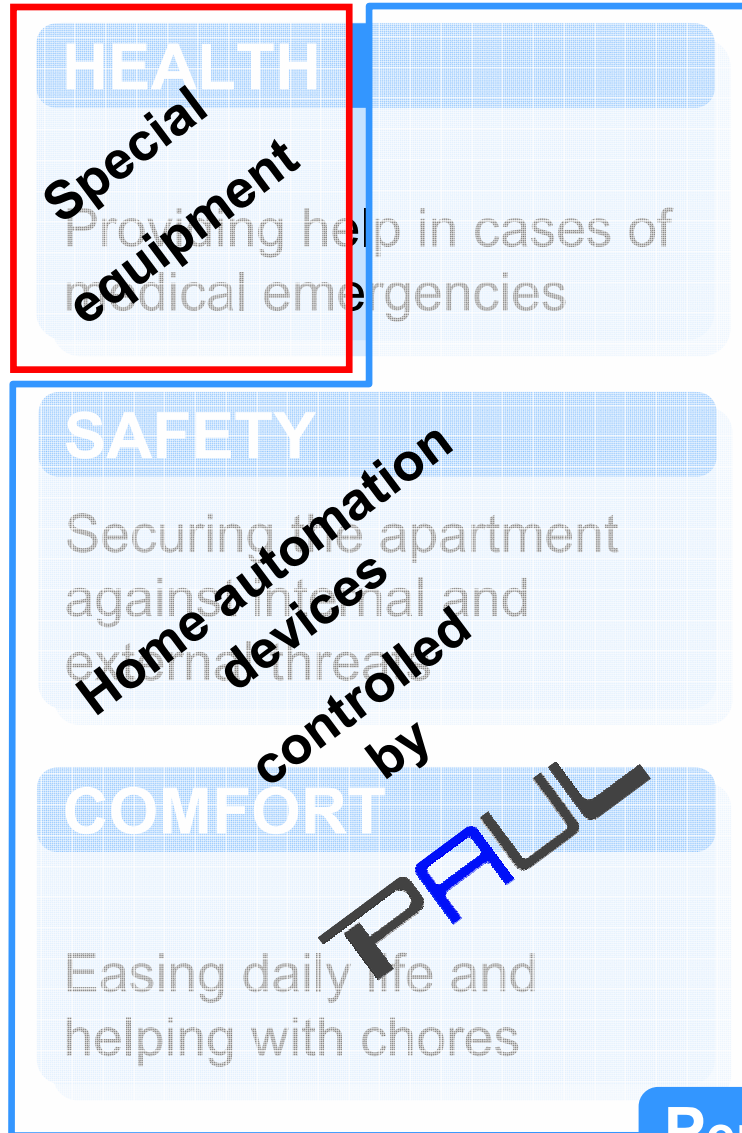
- Ambient Assisted Living (i.e. technically supported daily life)
- Barrier-free design of the living space
- Long-lasting integration into the social environment
- Socio-scientific assessment of the technological impact on seniors

Our Definition of Ambient Assisted Living

Concept to enable (senior) people to live independently in their accustomed homes and their social environments as long as possible by supporting their daily life with technical devices.

Our Partners in this Project

- Housing societies in Kaiserslautern, Speyer, Neuwied, and Mainz
- Working group for Urban Sociology headed by JP Dr A Spellerberg



- Identification: Activities of Daily Living
- Reminding of medication
- Fall detection

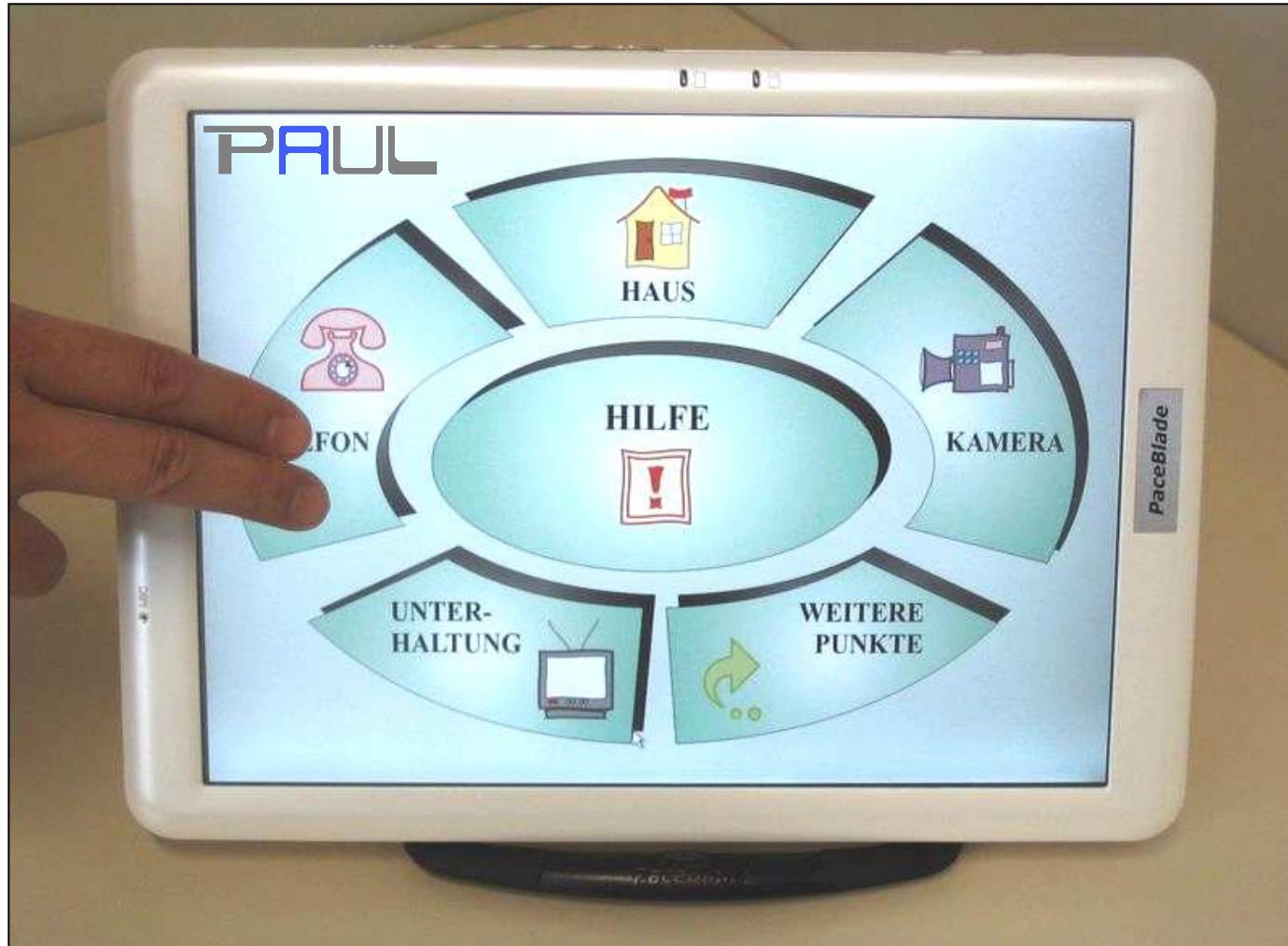
- Entry phone with video link
- Switching off critical loads
- Preventing water damage

- Electric roller blinds, automatic lighting
- Speed dialling with photos
- Alarm clock

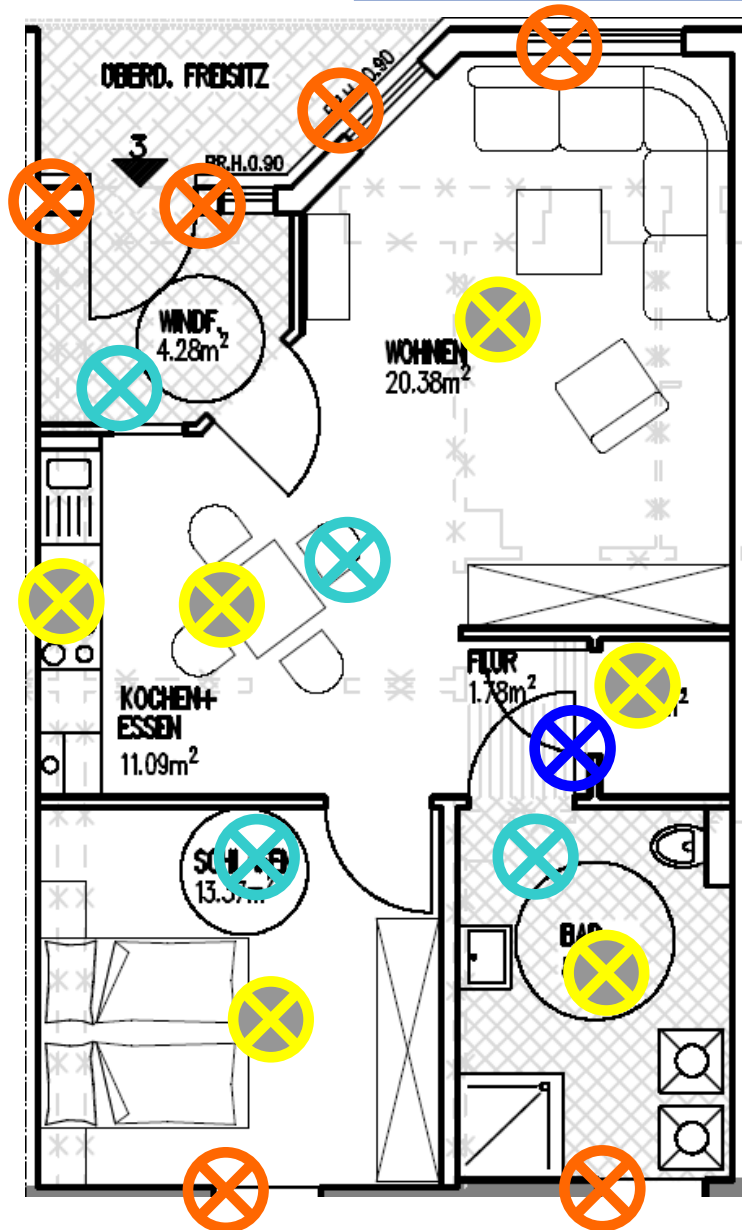
Personal Assistant Unit for Living





PAUL Personal Assistant Unit for Living

Overview ~ Introduction PAUL ~ Automata ~ Summary



Overview ~ Introduction PAUL ~ Automata ~ Summary



- 
 Door or window sensor including electrically driven roller blinds (Controlled by PAUL)
- 
 Motion detector
- 
 Lights controlled by PAUL
- 
 Water flow sensor

PAUL

Overview ~ Introduction PAUL ~ Automata ~ Summary

Data Storage

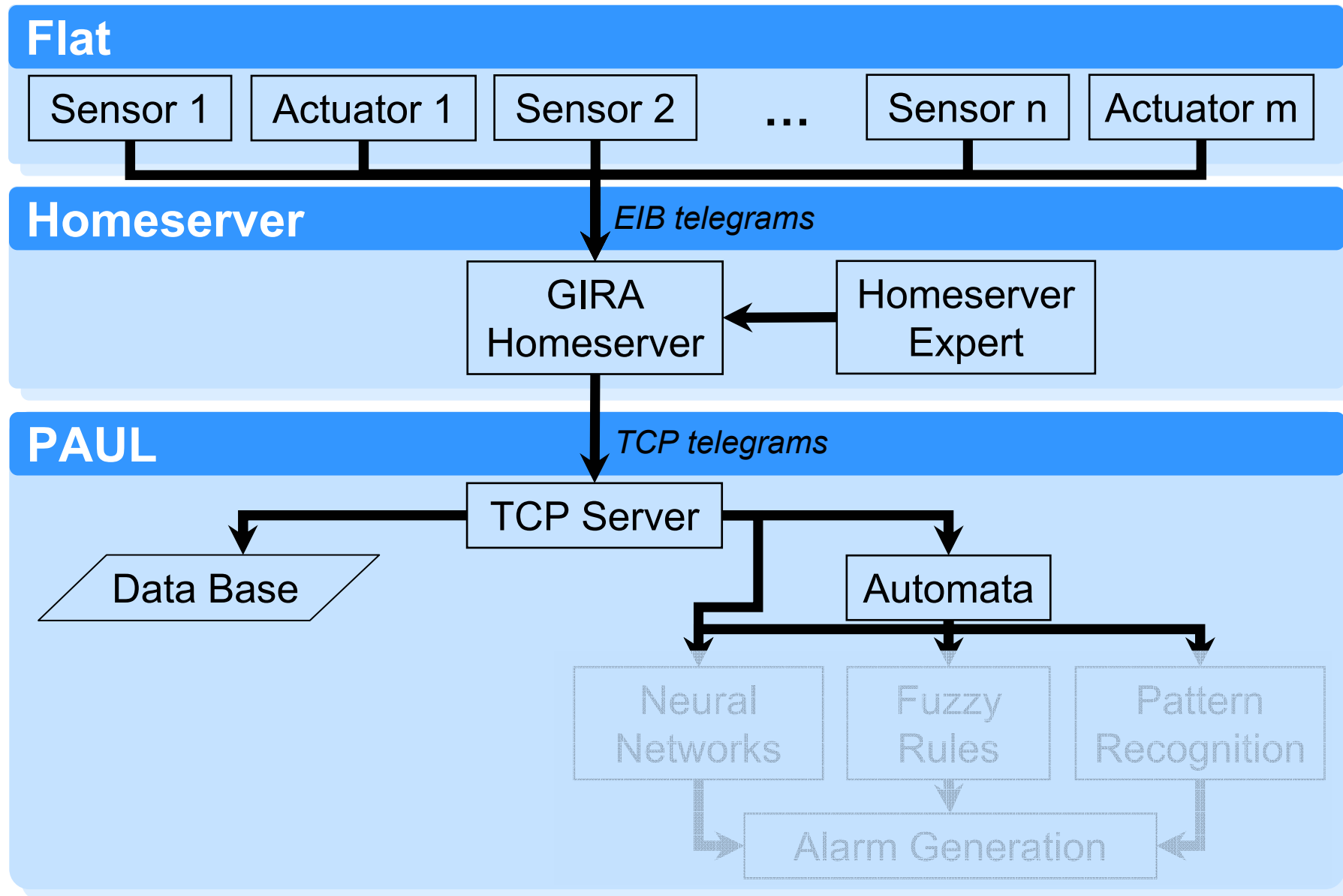
- Motion detectors
- Window sensors
- Door sensors
- Interactions with PAUL
- Water flow sensor
- Manual operation of wall switches
- ...

PAULs Tasks

- Control interface
- Data storage
- Data processing (Fuzzy Logic, Automata, Pattern Recognition, ...)
- Assessment of risk level and alarm generation

Threat Levels

- None: no alert
- Low: Feedback to user
- Medium: Message to neighbour/relative
- High: Service hotline
- Extreme: Emergency hotline



Automata

- Moore automata with event-triggered state transitions
- Events triggered by sensor telegrams
- Creation of complex automata by parallel composition of basic ones

The Automata Definition Framework

- Each automaton defined via a configuration file loaded when the program is run
- Possibility to load automaton definitions at runtime as well
- Each single sensor and also more complex scenarios modelled by automata (e.g. monitoring of inhabitant's presence)

Content of Definition File

- Name of automaton
- States (any number), initial state
- Input and output alphabet
- Transition and output function
- Timer properties

$A = (X, U, Y, f, g, x_0)$

X : Set of states,

U : Input alphabet,

Y : Output alphabet,

$f : X \times U \rightarrow X$: Transition function,

$g : X \rightarrow y \in Y$: Output function,

x_0 : Initial state.

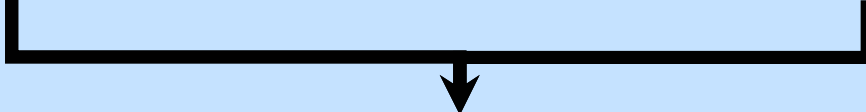
Properties of an Automaton once instanced

- Name
- Actual state
- List of all states
- List of all transitions
- List of observers, i.e. other automata to be notified of transitions
- List of other automata observed
- Timer (if required)

Formal Representation for Automata A_1 and A_2

$$A_1 = (X_1, U_1, Y_1, f_1, g_1, x_{0,1})$$

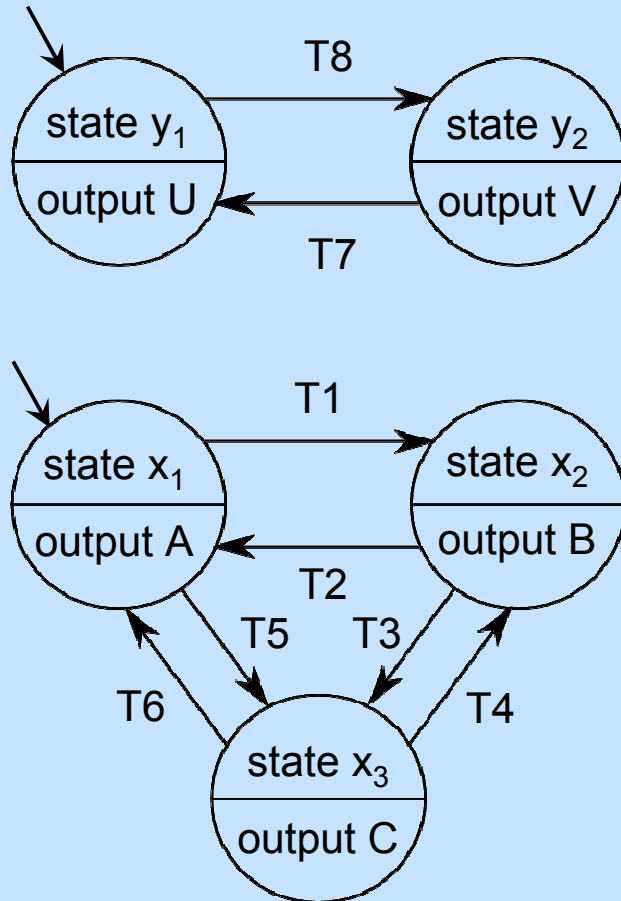
$$A_2 = (X_2, U_2, Y_2, f_2, g_2, x_{0,2})$$



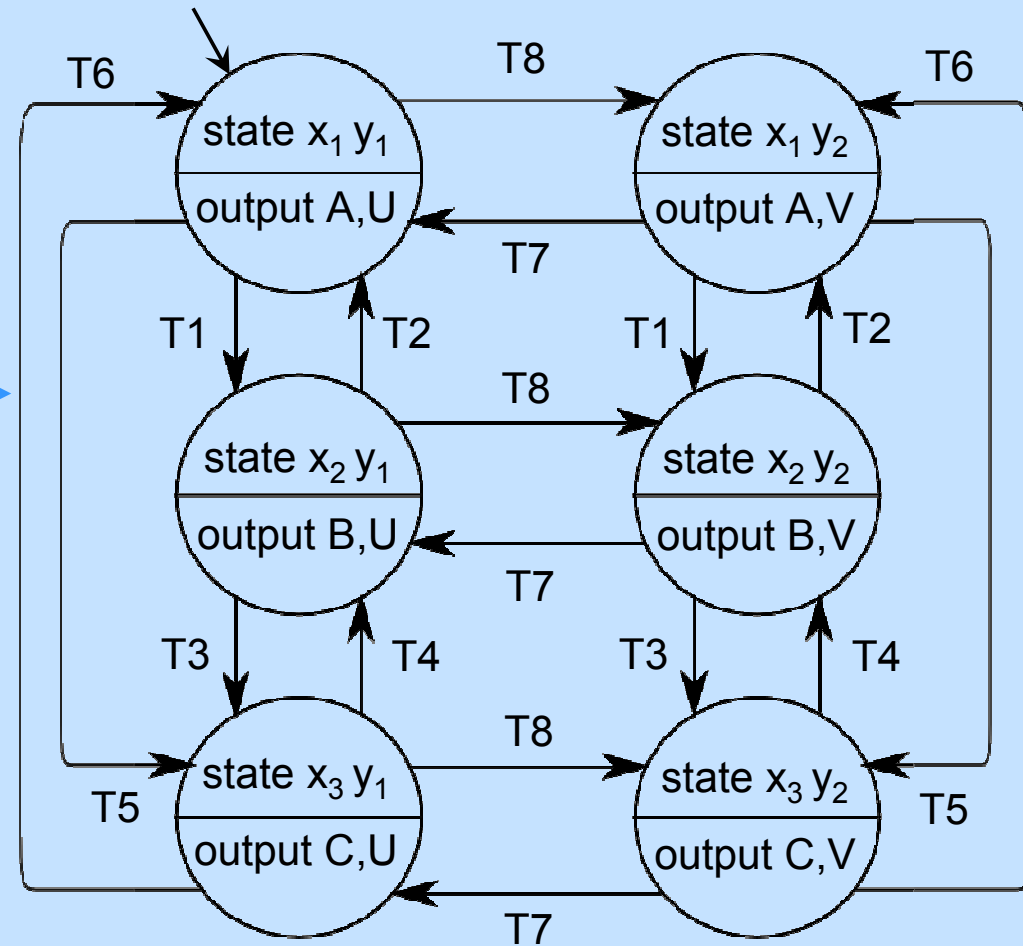
$$A_1 \parallel A_2 = (X_1 \times X_2, U_1 \cup U_2, Y_1 \times Y_2, f, g, (x_{0,1}, x_{0,2}))$$

$$f((x_1, x_2), e) := \begin{cases} (f_1(x_1, e), f_2(x_2, e)) & \text{if } f_1(x_1, e) \text{ and } f_2(x_2, e) \text{ defined} \\ (f_1(x_1, e), x_2) & \text{if } f_1(x_1, e) \text{ defined only} \\ (x_1, f_2(x_2, e)) & \text{if } f_2(x_2, e) \text{ defined only} \\ \{\} & \text{else} \end{cases}$$

Initial Automata

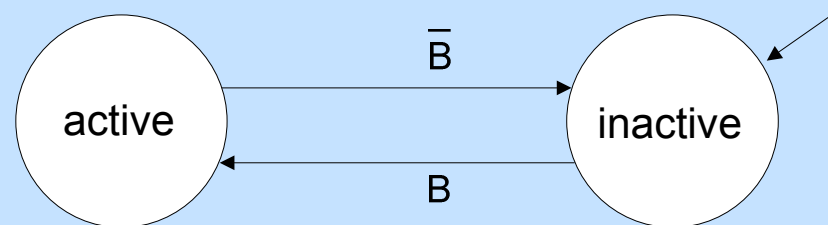


Resulting Automaton

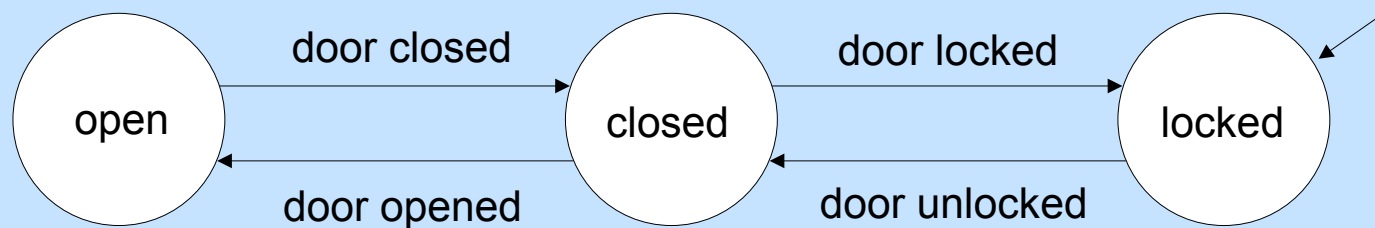


- Presence monitoring crucial for analysis and interpretation of activities of daily living!
- Combination of more than one sensor for more complex situations to be tracked

Motion Detector



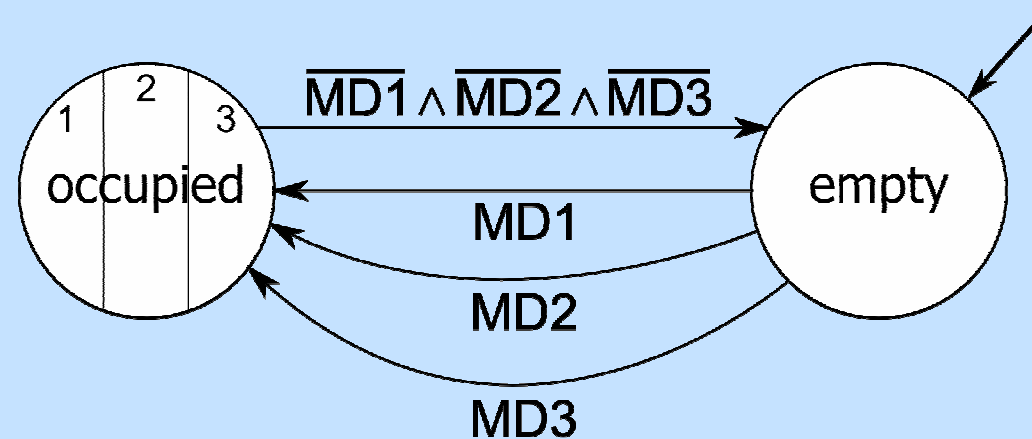
Deadbolt & Reed Contact



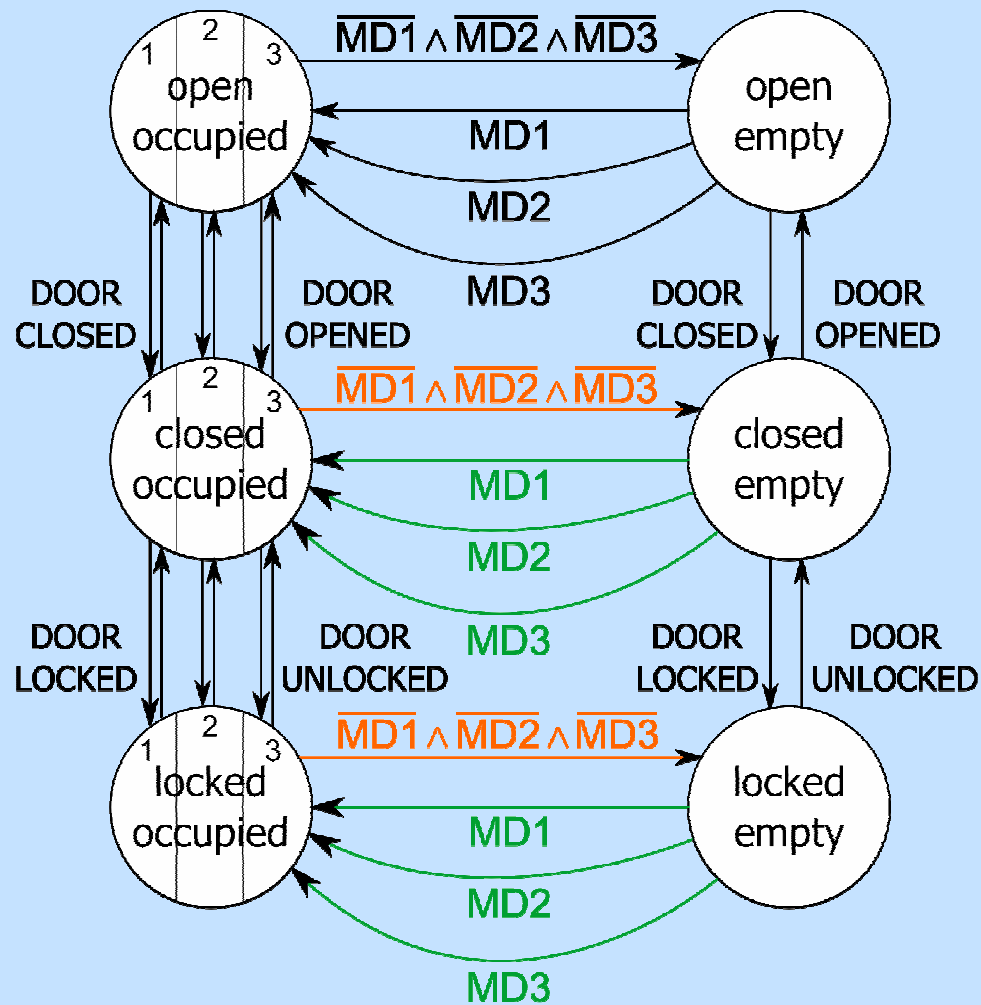
- Use of three sensor signals for diagnosing presence
- Merging of three motion detector automata for increased robustness

Overview ~ Introduction PAUL ~ Automata ~ Summary

Merged Automaton



Automaton monitoring Presence



- Parallel composition of Automata done automatically by the Automata Engine
- Additional colored transitions to increase robustness
- **ORANGE** to account for limitations of the used motion detectors
- **GREEN** to improve performance in case of more than one person living in a flat

Summary

- Two real world AAL projects to be launched shortly
- Data acquisition (data base) operational
- Development of automata engine framework completed
- Implementation of basic automata
- Automatic data transfer to develop and test new data processing algorithms

Outlook

- Definition of more sophisticated automata once real data available
- Implementation and testing of more advanced data mining algorithms (fuzzy rules, pattern recognition, ...)
- Development of automatic alarm generation schemes

Thank you very much for your attention!

Any questions?

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Research Group
Ambient Intelligence