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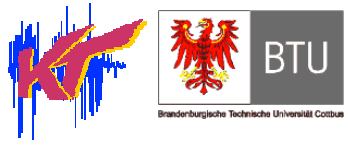
Human-Computer Interaction in a Smart Home Environment

Klaus Fellbaum
Maik Hampicke



Communication Engineering
Brandenburg University of Technology, Cottbus

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Smart Home

Smart Home Definition

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Smart Home and Smart Home Environment

- Home (including the narrow environment) with smart technology and services.

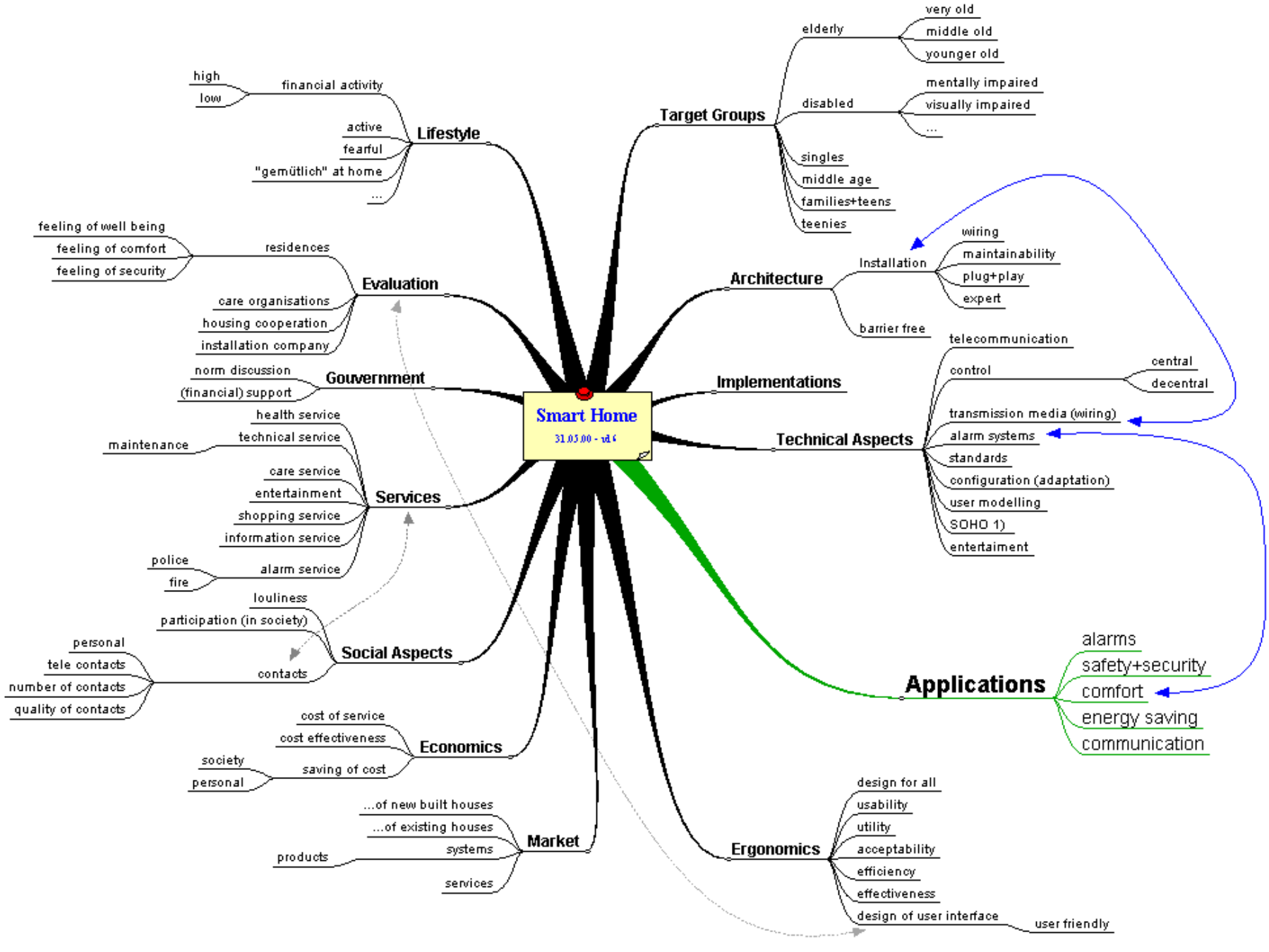
Aim...

Integrating, automating and improving

- safety & security,
- communication,
- comfort and,
- energy saving.

Prerequisites:

- Networking,
- adaptation to the user's needs


Smart Home
31.03.00 - v0.6
Target Groups
elderly
very old
middle old
younger old
disabled
mentally impaired
visually impaired
...
singles
middle age
families+teens
teenies
Architecture
Installation
wiring
maintainability
plug+play
expert
barrier free
Implementations
Technical Aspects
telecommunication
control
central
decentral
transmission media (wiring)
alarm systems
standards
configuration (adaptation)
user modelling
SOHO 1)
entertaiment
Applications
alarms
safety+security
comfort
energy saving
communication
Ergonomics
design for all
usability
utility
acceptability
efficiency
effectiveness
design of user interface
user friendly
Market
...of new built houses
...of existing houses
systems
products
services
Economics
cost of service
cost effectiveness
saving of cost
society
personal
Social Aspects
louliness
participation (in society)
contacts
personal
tele contacts
number of contacts
quality of contacts
Services
health service
technical service
maintenance
care service
entertainment
shopping service
information service
alarm service
police
fire
Gouvernment
norm discussion
(financial) support
Evaluation
residences
feeling of well being
feeling of comfort
feeling of security
care organisations
housing cooperation
installation company
Lifestyle
financial activity
high
low
active
fearful
"gemütlich" at home
...

Smart Home Example

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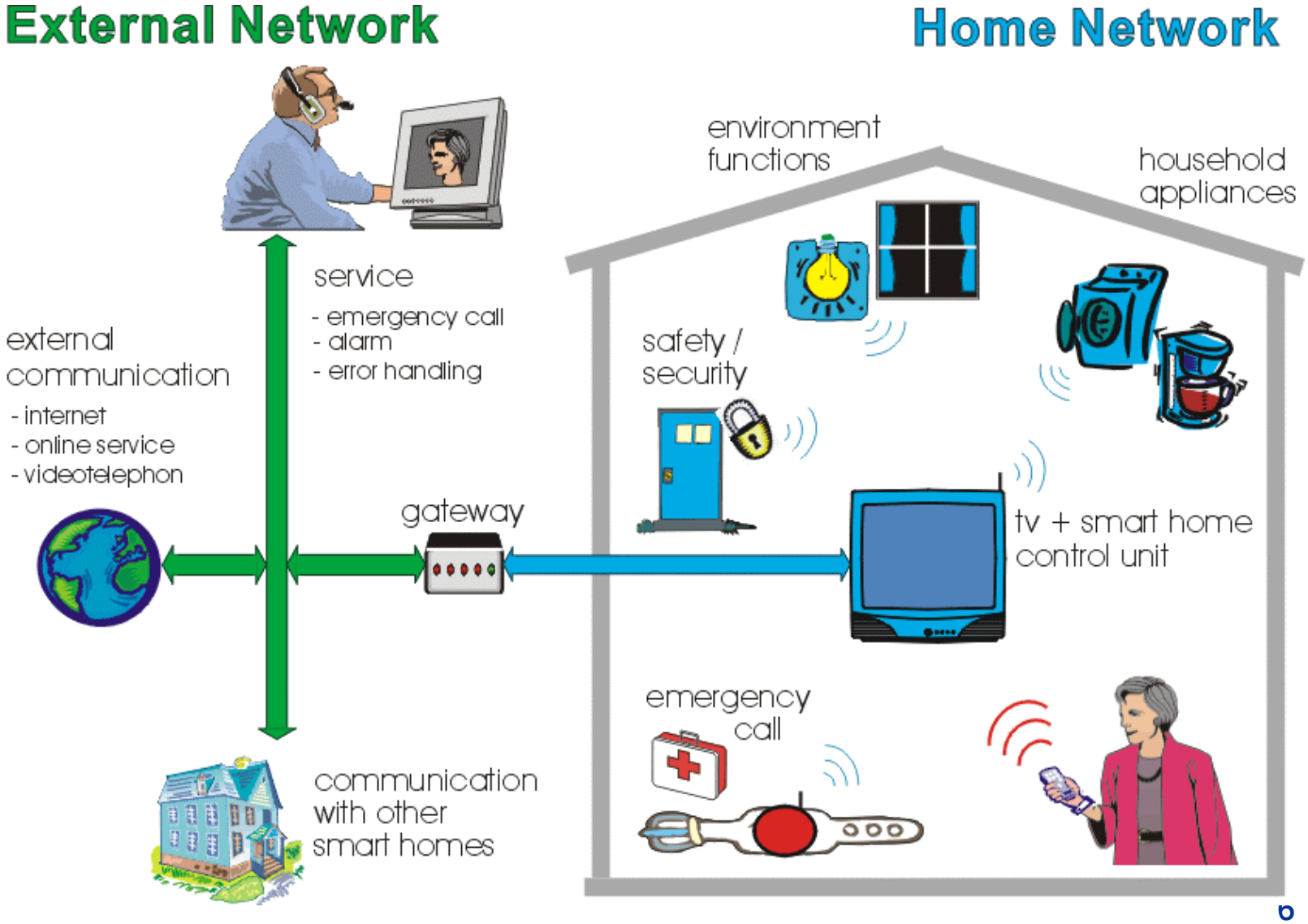

Learning Home I

Learning Home: Simulation environment for the Sentha project

Aim

- Realisation,
- demonstration,
- test and evaluation of smart home functions,
- test bed for elderly persons.

Components

- Network,
- control tools, sensors and actuators
- user interfaces,
- speech processing tools (speech and speaker recognition).

Sentha's Learning Home II

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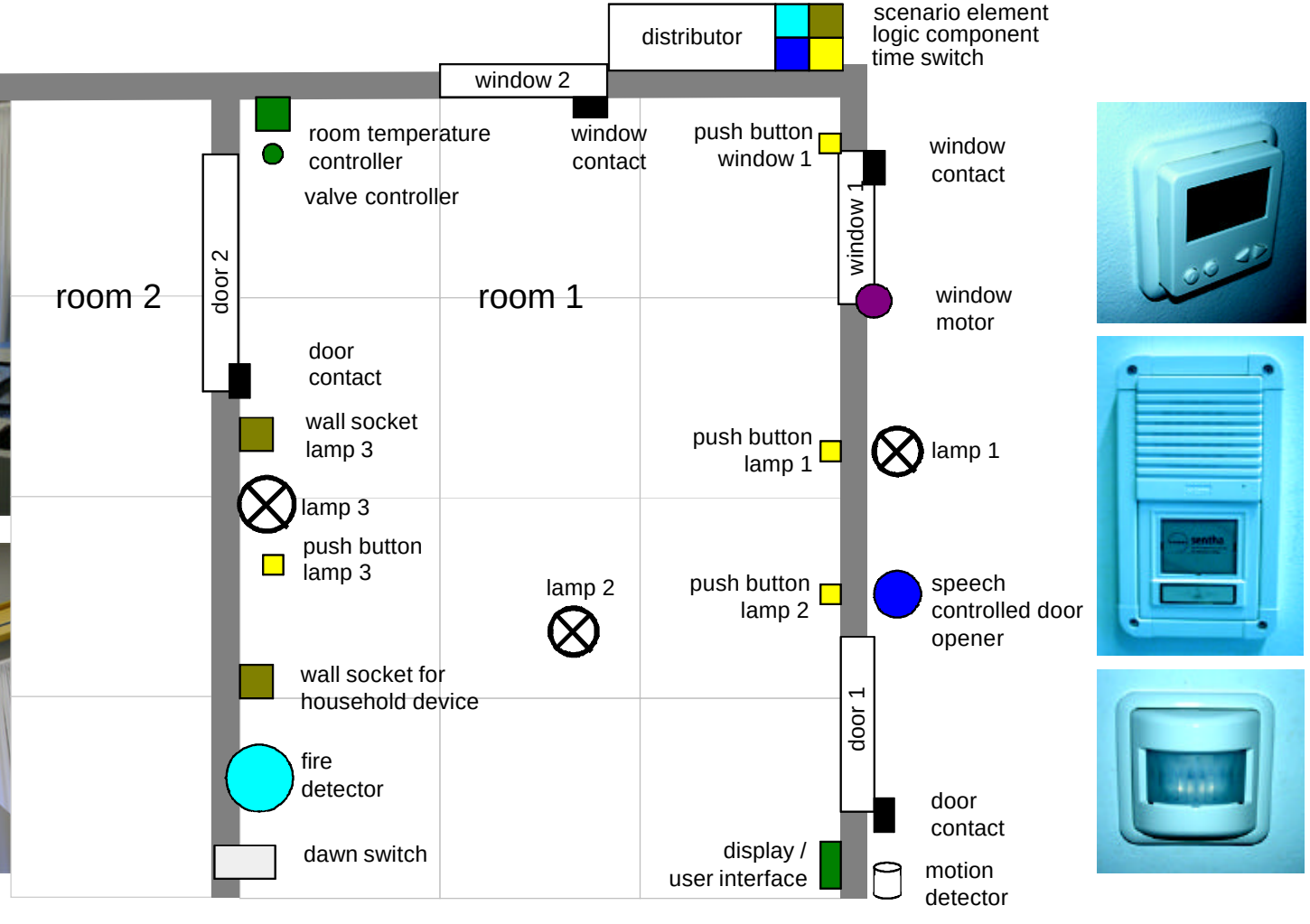

User Interfaces for Smart Homes

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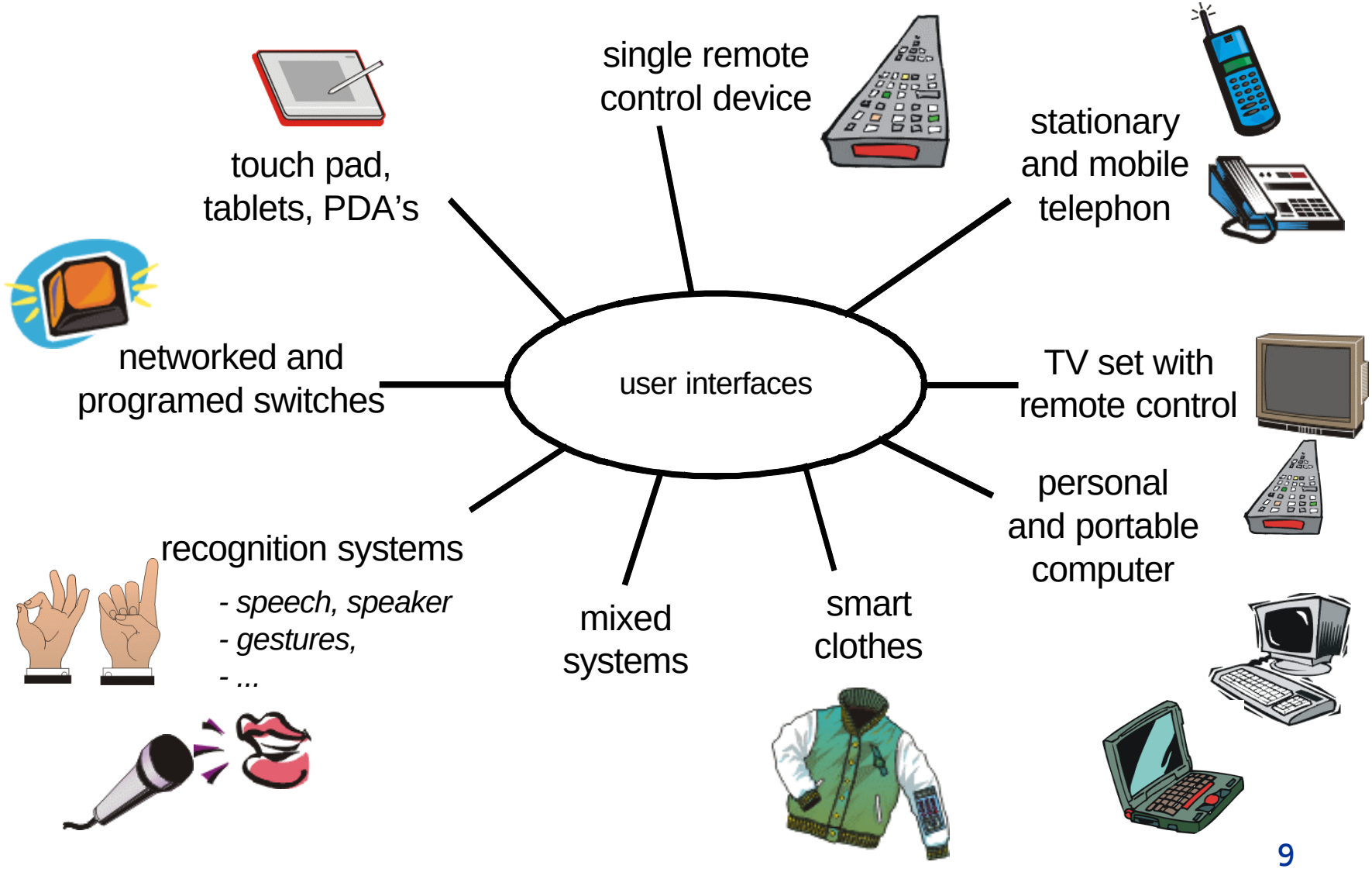

Speech Recognition and Speech Interface

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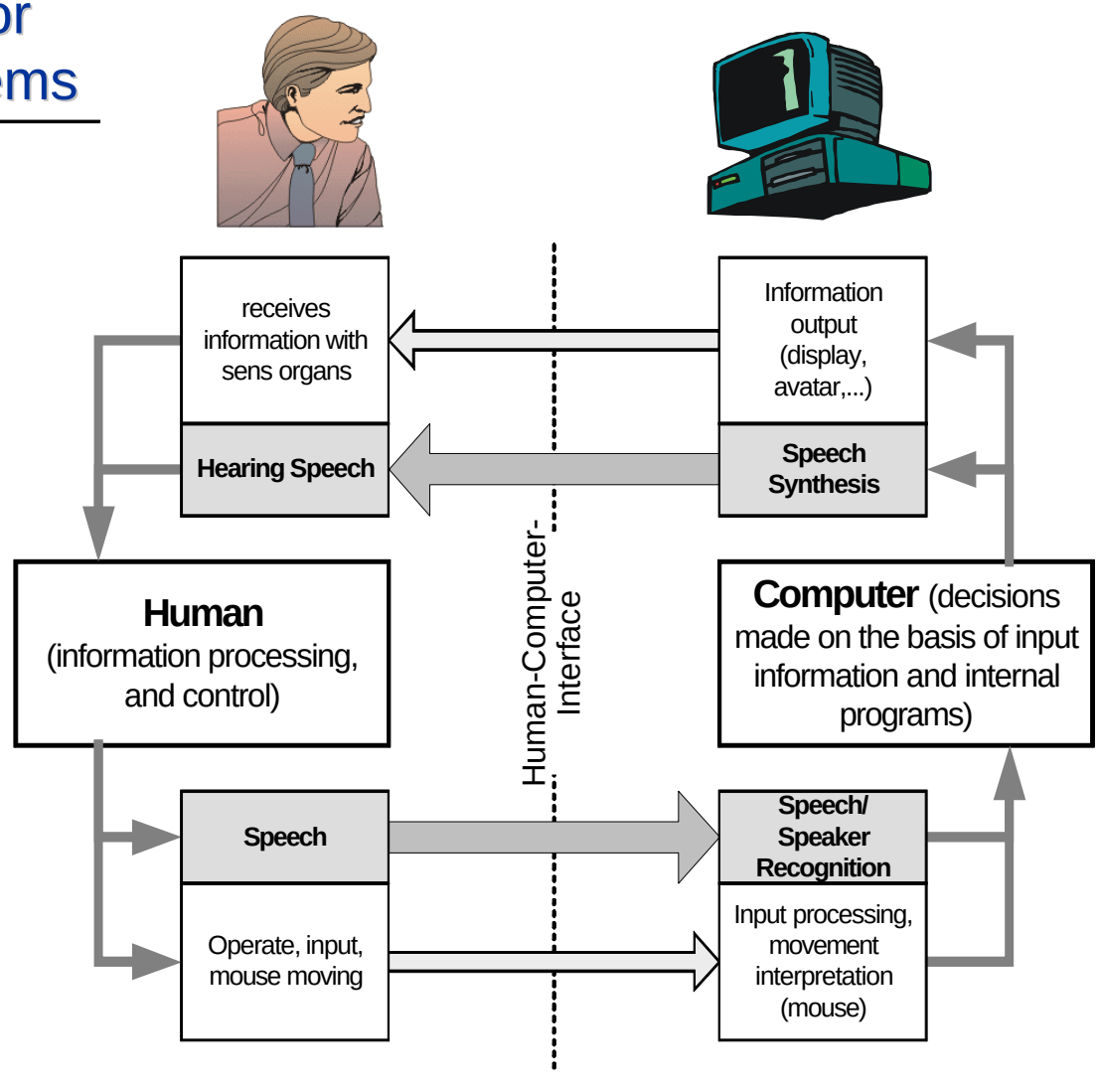
Influence parameters for speech recognition systems

- speech dialog structure,
- user discipline,
- error handling,
- feedback control,
- background noise, non-speech effects,
- system activation,
- speech vocabulary,
- training period,
- hardware design.



Speech Recognition (Applications)

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Voice Control of…

- telephone (acoustic dialing)
- tv and hifi devices
- alarm systems
- household appliances
- environment control systems (light, heating, air conditioner,...)
- door/window opener
- robots

Speech Recognition (State of the art)

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Isolated word recognition (speaker adaptive)

- many systems on the market
- very different recognition accuracy (70...95%)
- mostly as add-on to PCs (software solution), very few stand-alone systems
- low price (range $10...$100)
- (mostly) serious adaptation/integration problems
- (mostly) awkward training procedures
- noise sensitivity

Speech Recognition (State of the art)

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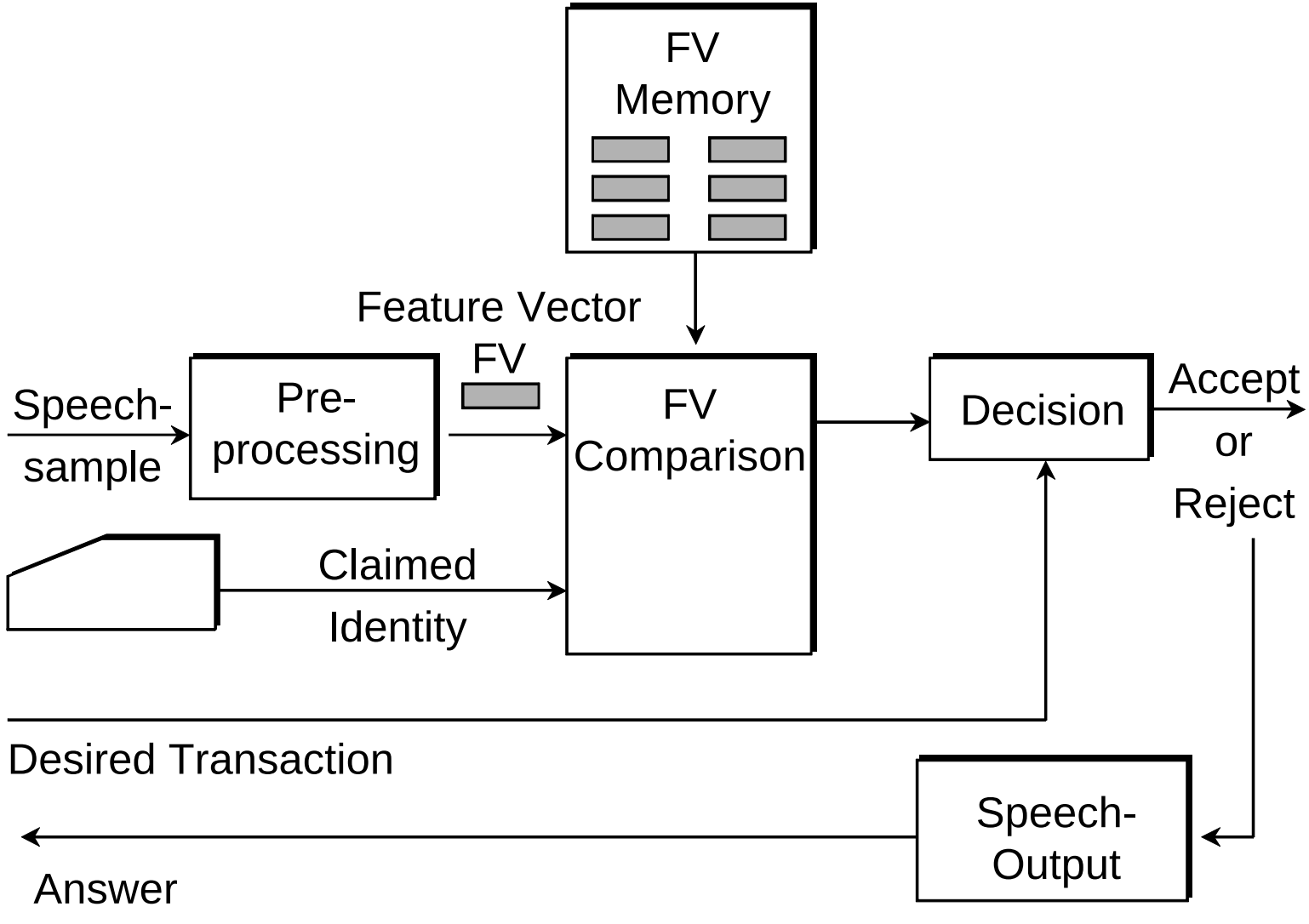
Continuous speech recognition

- few systems on the market
- very different recognition accuracy (60...80%)
- mostly as add-on to PCs (software solution), very few stand-alone systems
- expensive (> $100)
- (mostly) serious adaptation / integration problems
- (mostly) awkward training procedures
- noise sensitivity

...need for smart home applications ???

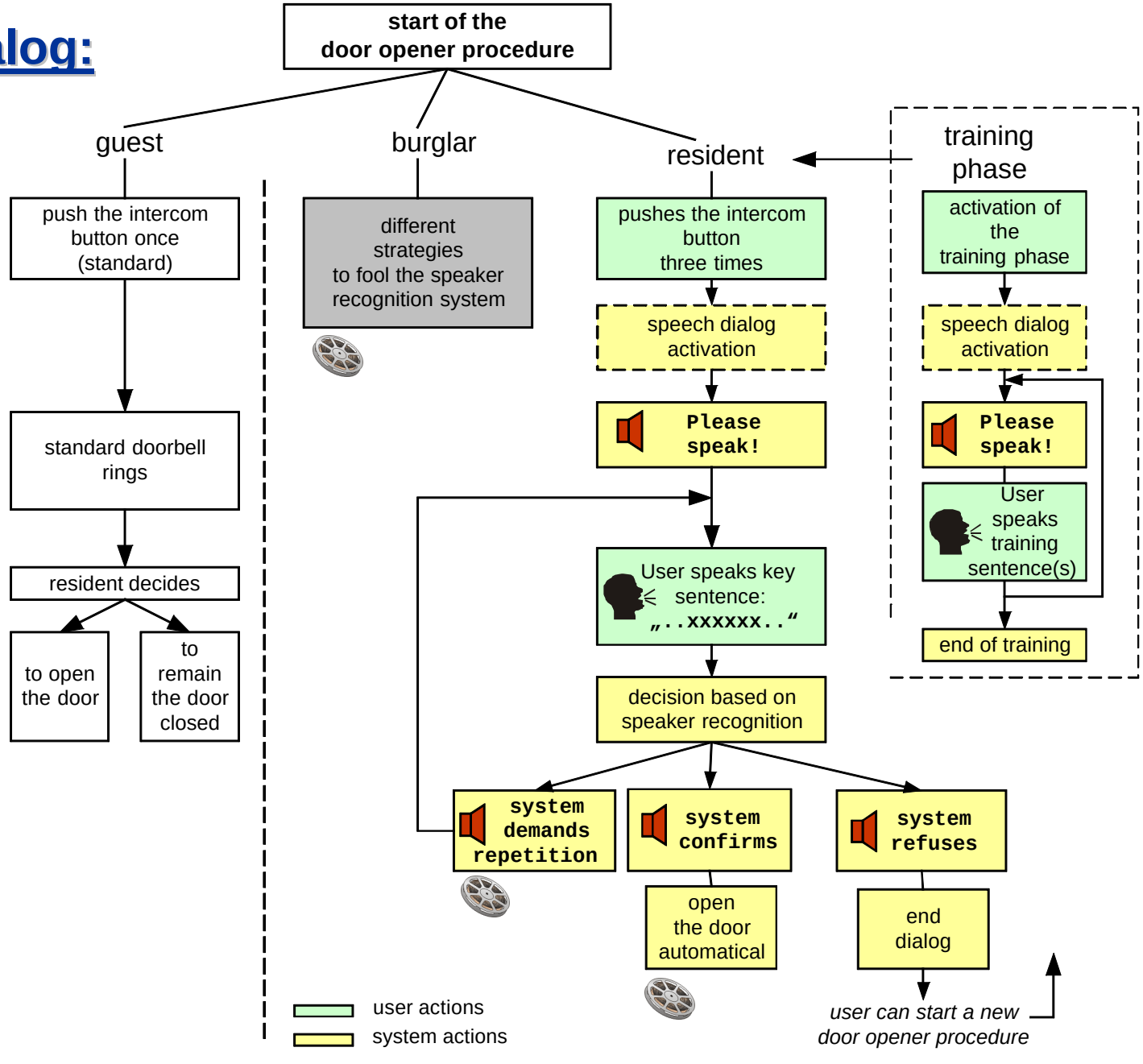
Speaker Recognition

Principle of speaker recognition



Speech Dialog:

Example: opening of the main door



Investigations and Results

Evaluation of young and elderly persons about pro's and cont's of a speech recognition system

Results:

- Speech recognition (voice control) is the top solution, if …
  - the recognition accuracy is high enough (>95 %)
  - the user has a certain experience
  - it is used for simple command and control functions

  - For control of more complex functions a *mixed* interface (graphic, audio,…) is preferable → better for feedback and error handling.

Investigations and Results II

- System training was too long (50 sentences were necessary) → decrease of concentration and speaking discipline.
- User became impatient, made comments and turned their face away from the microphone.
- A little insight into the mechanism of speech recognition improved the results.
- An acoustic or visual signal as request to start speaking was found to be very useful.

Summary and Conclusions

Summary and Conclusions

- Speech components have been proved as very important in a smart home environment.
- Concerning the successful use of speech and speaker recognition, there was no significant difference between younger and older users, but experience and training played a key role.
- A careful design and integration of the speech interface is of crucial importance.
- Speech components have to be carefully embedded into a general human computer interaction concept. The key problem is the optimal mixture of acoustic and visual information in both, the input and the output interface. The mixture differs individually and must be adapted individually.
- Human computer interaction must not restrict the personal freedom to do things ‘by hand’, the feeling to be dependend on a technical system has to be avoided.