Collaboration Bus

Research Project Midterm Presentation

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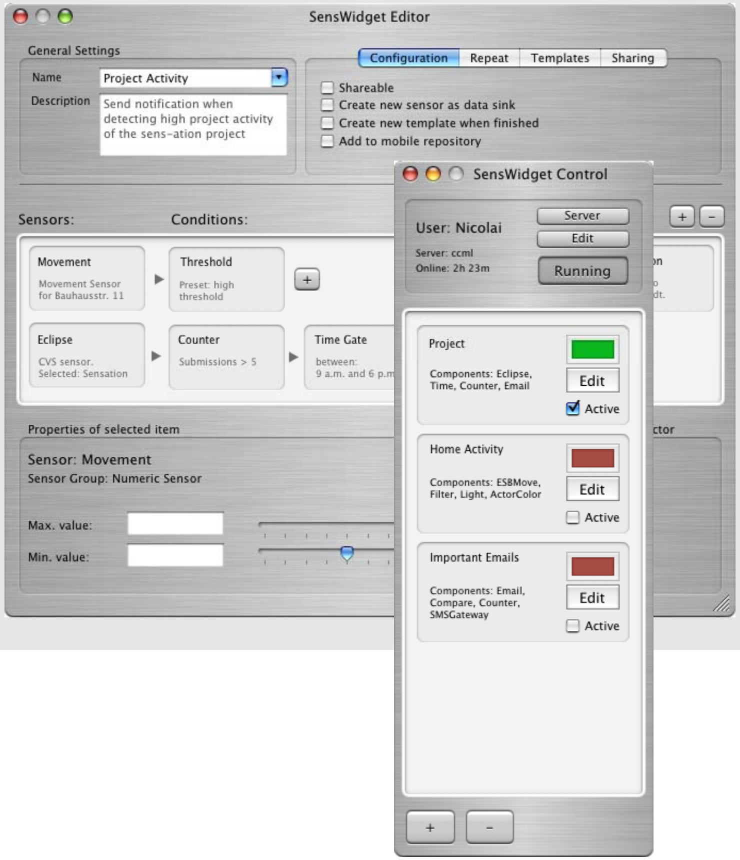


SensWidget Editor

General Settings

Name: Project Activity

Description: Send notification when detecting high project activity of the sens-ation project

☐ Shareable
☐ Create new sensor as data sink
☐ Create new template when finished
☐ Add to mobile repository

Sensors: Conditions:

Movement: Movement Sensor for Bauhausstr. 11 ▶ Threshold: Preset: high threshold

Eclipse: CVS sensor. Selected: Sensation ▶ Counter: Submissions > 5 ▶ Time Gate: between: 9 a.m. and 6 p.m

Properties of selected item

Sensor: Movement
Sensor Group: Numeric Sensor

Max. value:
Min. value:

SensWidget Control

User: Nicolai
Server: ccml
Online: 2h 23m

Project 🟩
Components: Eclipse, Time, Counter, Email
☑ Active

Home Activity 🟥
Components: ESBMove, Filter, Light, ActorColor
☐ Active

Important Emails 🟥
Components: Email, Compare, Counter, SMSGateway
☐ Active

Outline

1 Introduction and Related Work

2 Concept and Architecture

3 Technology, Implementation and Design

4 Example Scenarios

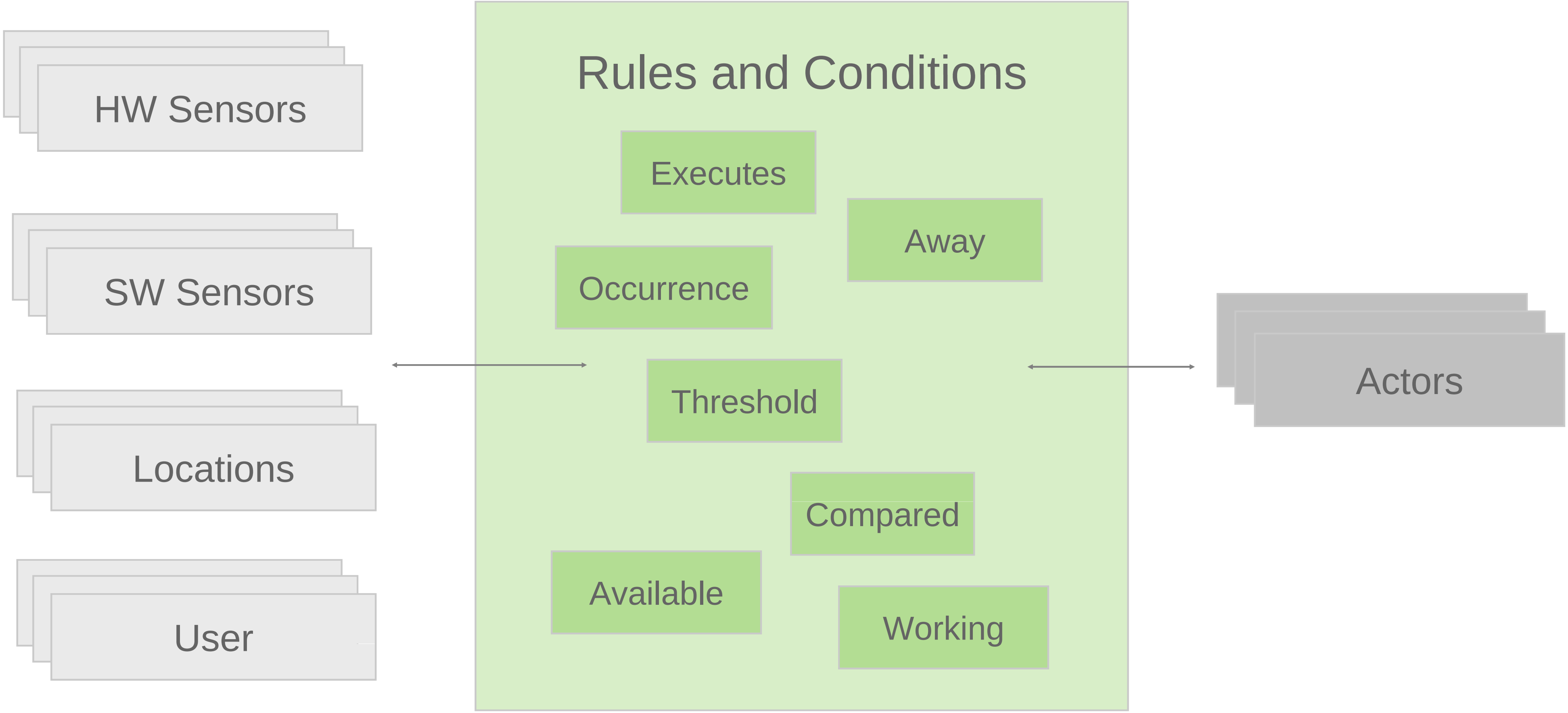
5 Summary

Motivation

- *Initial position: Existing infrastructure with software/hardware sensors and actors (at home and/or in the office)*

- Provide an easy-to-use method to integrate sensing and automated activities into everyday life (personal as well as business)
- Hide details of the technology (sensors, actors, platform) and the configuration of these components
- Consider personalized properties to represent the individual preferences and interpretations
- Exchange and share knowledge (and these personal interpretations)
- Control of the sensor-actor connections, but with guided support of the system

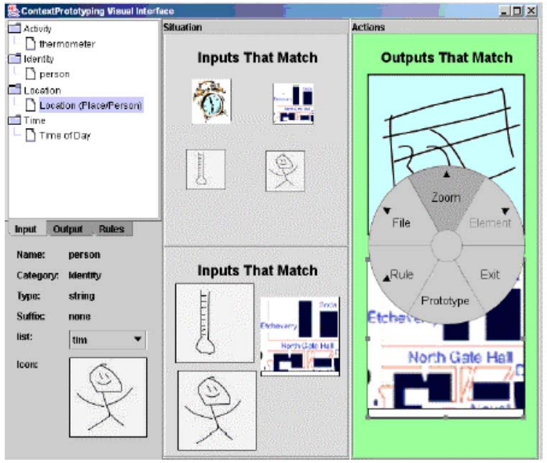
Motivation


HW Sensors
SW Sensors
Locations
User
Rules and Conditions
Executes
Away
Occurrence
Threshold
Compared
Available
Working
Actors

Related Work (1)

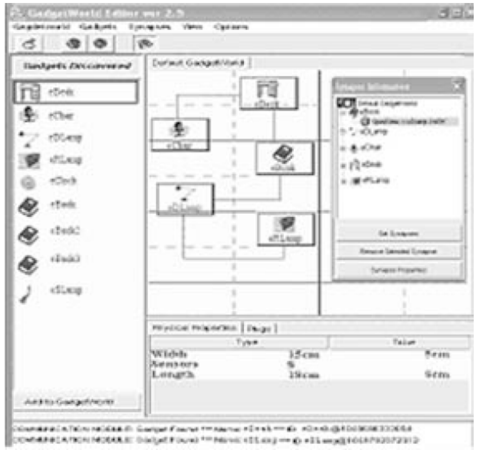
1. Visual programming for UbiComp applications
   - Edit control networks for the in-home environment
   - Often with mobile device interfaces: PDA [Mavrommati et al. 2004], mobile phone [Barkhuus & Vallgarda 2003] or TabletPC [Humble et al. 2003]
   - Composition interface of sensors and conditions [Dey & Sohn 2003], Network editor [Mavrommati et al. 2004]

[Mavrommati et al. 2004]

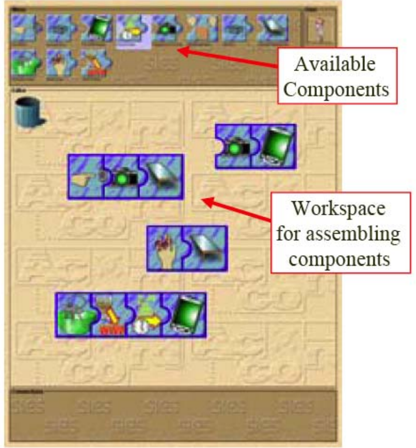


Name: person
Category: Identity
Type: string
Suffix: none
list: tim
Icon:

[Dey & Sohn 2003]



[Mavrommati et al. 2004]

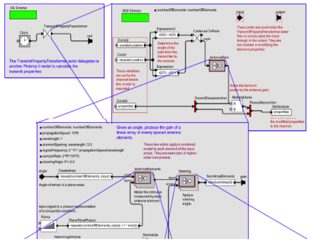


[Humble et al. 2003]

Related Work (2)

2. Sensor network composition software
   - Control over fine granular sensor network communication and processing [Baldwin et al. 2004]
   - Complete programming language, operator sets, math. libraries, etc.
   - Complex development environments, e.g. iConnect Micro-Epsilon
   - Integrated in business applications or science applications, e.g. Matlab

3. Visual programming languages
   - Enable the end-user to develop software components [Zhang et al. 2004]
   - Commercial products, e.g. HP VEE



[Baldwin et al. 2004]

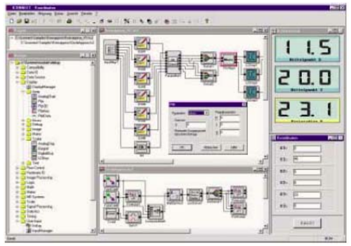
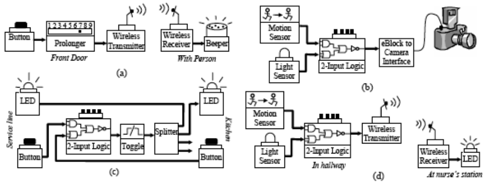


Fig.: iConnect, Micro-Epsilon



[Cotterell et al. 2004]

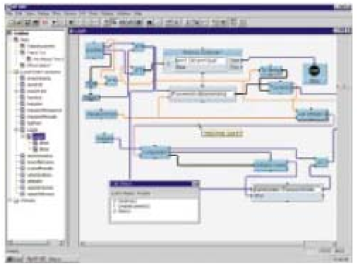
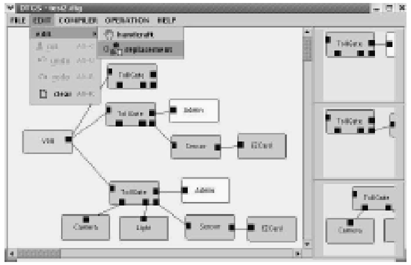


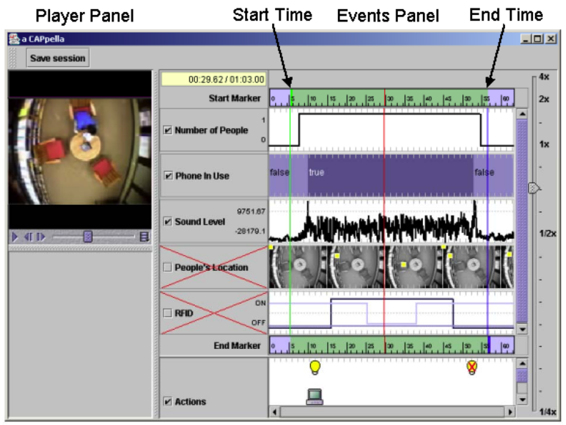
Fig.: Hewlett-Packard



[Zhang et al. 2004]

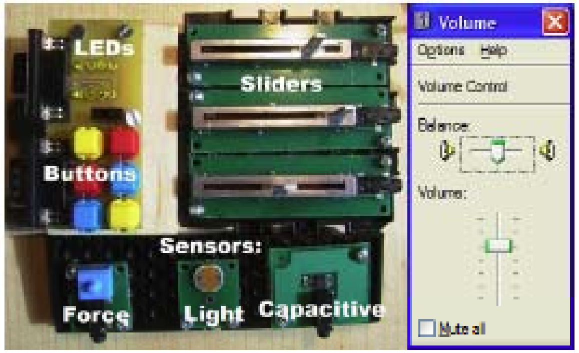
Related Work (3)

4. Programming by demonstration
   - In Ubiquitous Computing: longer period of observation, then definition and learning phase, so that AI algorithms detect patterns [Dey et al. 2004]
   - Hide all specific details of the underlying mechanisms



[Dey et al. 2004]

6. Physical Representation
   - E.g. the Phidgets project of Saul Greenberg: associations between sensors, software and real objects [Greenberg & Fitchett 2001]
   - Implementation: ActiveX Controls in .NET
   - Also: ambient interfaces



[Greenberg & Boyle 2002]

Related Work

Findings: [Hague et al. 2001], [Cotterell & Vahid 2005], [Humble et al. 2003], [Cotterell et al. 2004], [Rodden et al. 2004], [Crabtree et al. 2004]:

- Users would like to control and program the sensor-based applications and build new ones; but without to much specific knowledge needed
- They also would like to have the option, to change the behavior of their developed applications (dynamic) and to control them (activate, deactivate)
- Boolean conditional tables (logic blocks) are difficult to understand for the most users, so they need support
- Users need support for using the interface (guide the user, hide optional parameters, use icons and color, etc.)
- Most of the conditional networks in the related work are built with three up to ten components and can be mapped to parallel pipes

Related Work: Conclusions

The different approach of Collaboration Bus:

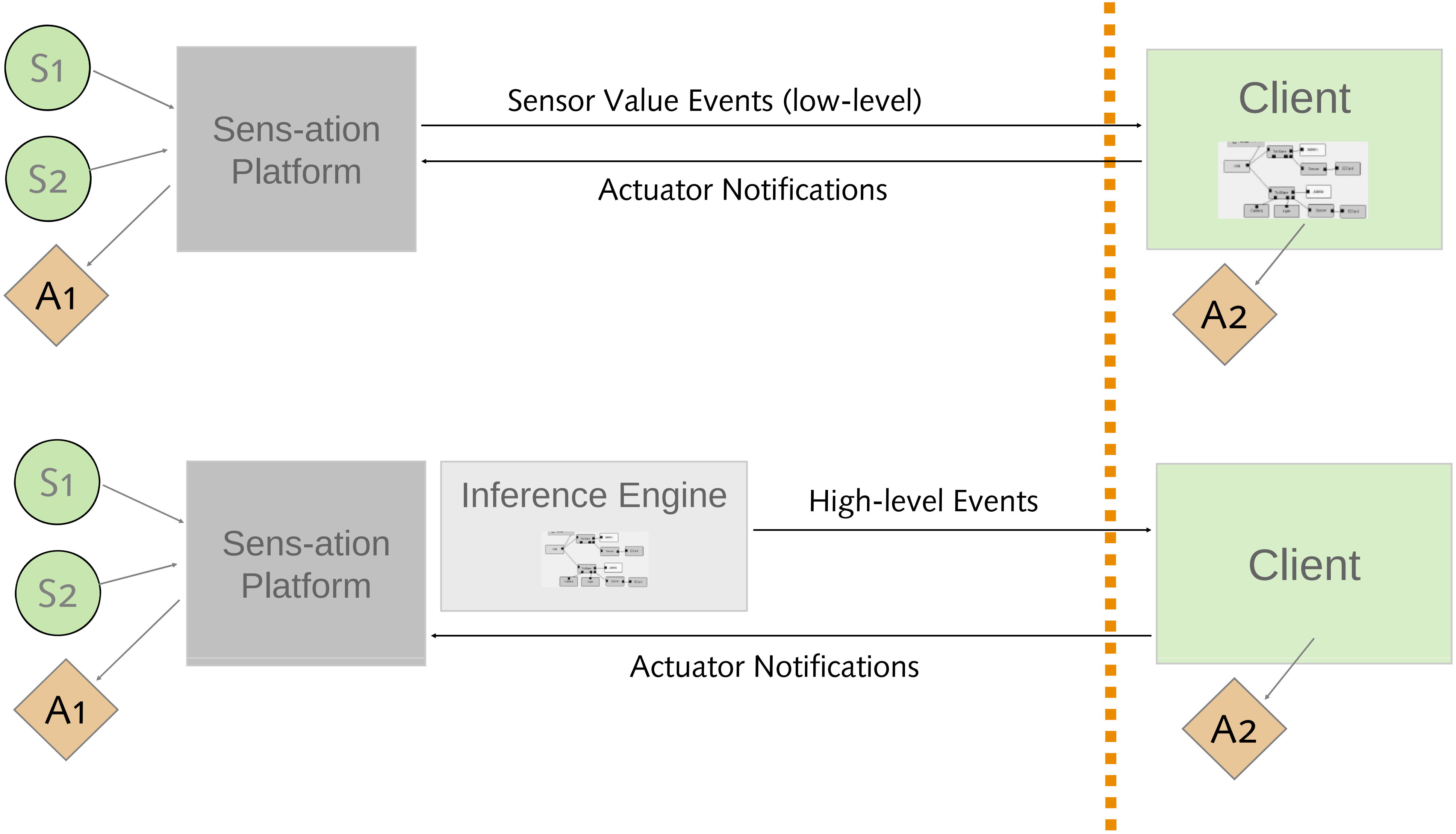
1. Focus especially on smaller data flow definitions to support and enhance work and everyday life
2. Intuitive, easy-to-learn interface, with specialized functions (not too generic)
3. Hiding the graph theory as much as possible
4. Sharing mechanism, exchange of data flows
5. The „repository“ view, personal control
6. Templates and patterns of flow definitions
7. No replacement for the complex „inference engine“ modules
8. Covers *Ubiquitous Computing* and *CSCW* applications

Building Sensor-based Applications

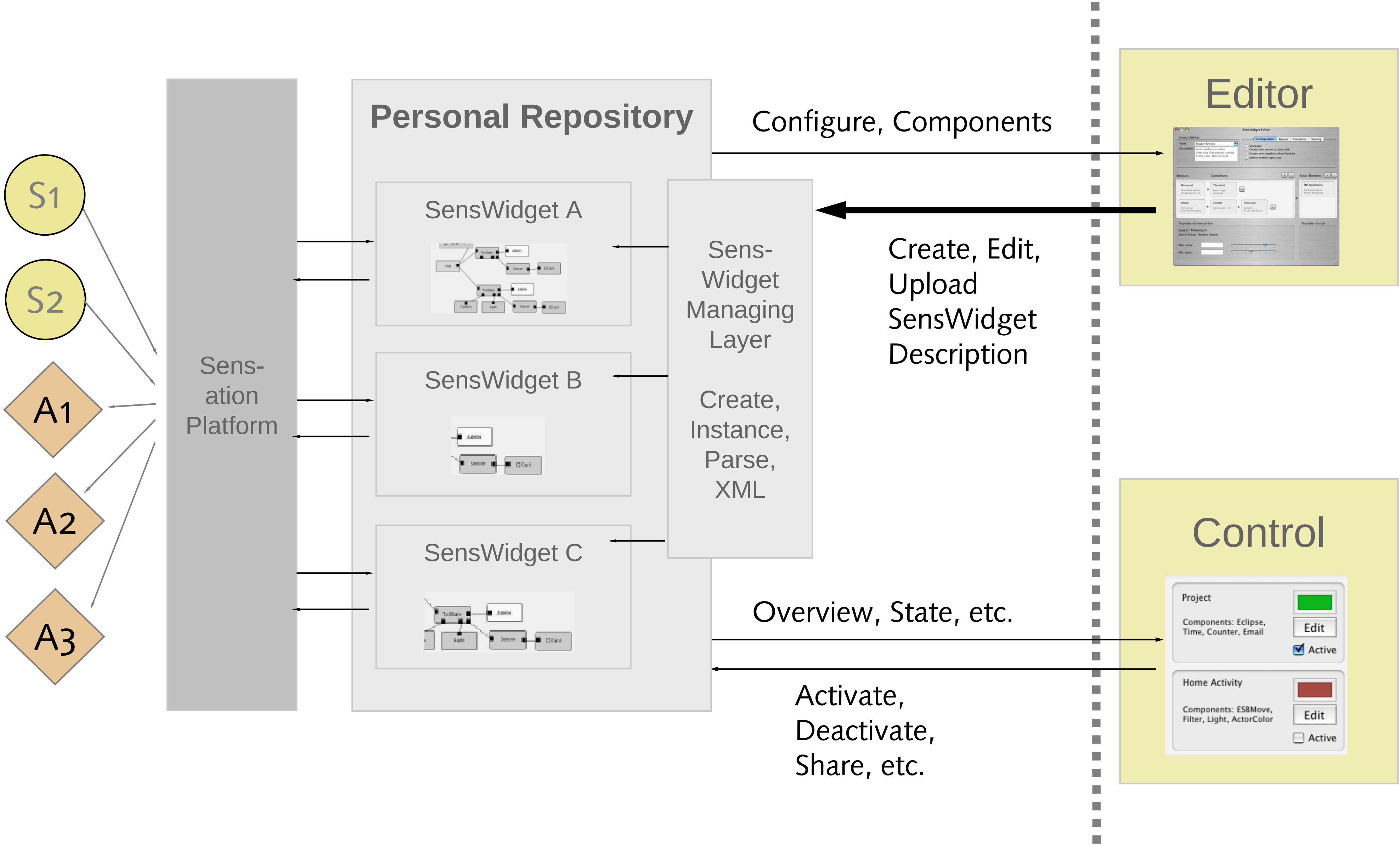
1. Hardware level: nodes communication
2. Using framework: adapters, classes, hard coded
3. Widgets for software development (e.g. Context Toolkit)
4. Software development using libraries, visual IDE (e.g. Phidgets with ActiveX controls)
5. Visual editor, editing data flow networks, graph theory
6. Visual editor, guided network composition, adaptive
7. Wizard dialog, step-by-step pages
8. Automatic application (network) creation based on problem description, AI algorithms

User centric

Sens-ation: New Applications



Collaboration Bus



S1

S2

A1

A2

A3

Sens-
ation
Platform

Personal Repository

SensWidget A

SensWidget B

SensWidget C

Sens-
Widget
Managing
Layer

Create,
Instance,
Parse,
XML

Configure, Components

Create, Edit,
Upload
SensWidget
Description

Overview, State, etc.

Activate,
Deactivate,
Share, etc.

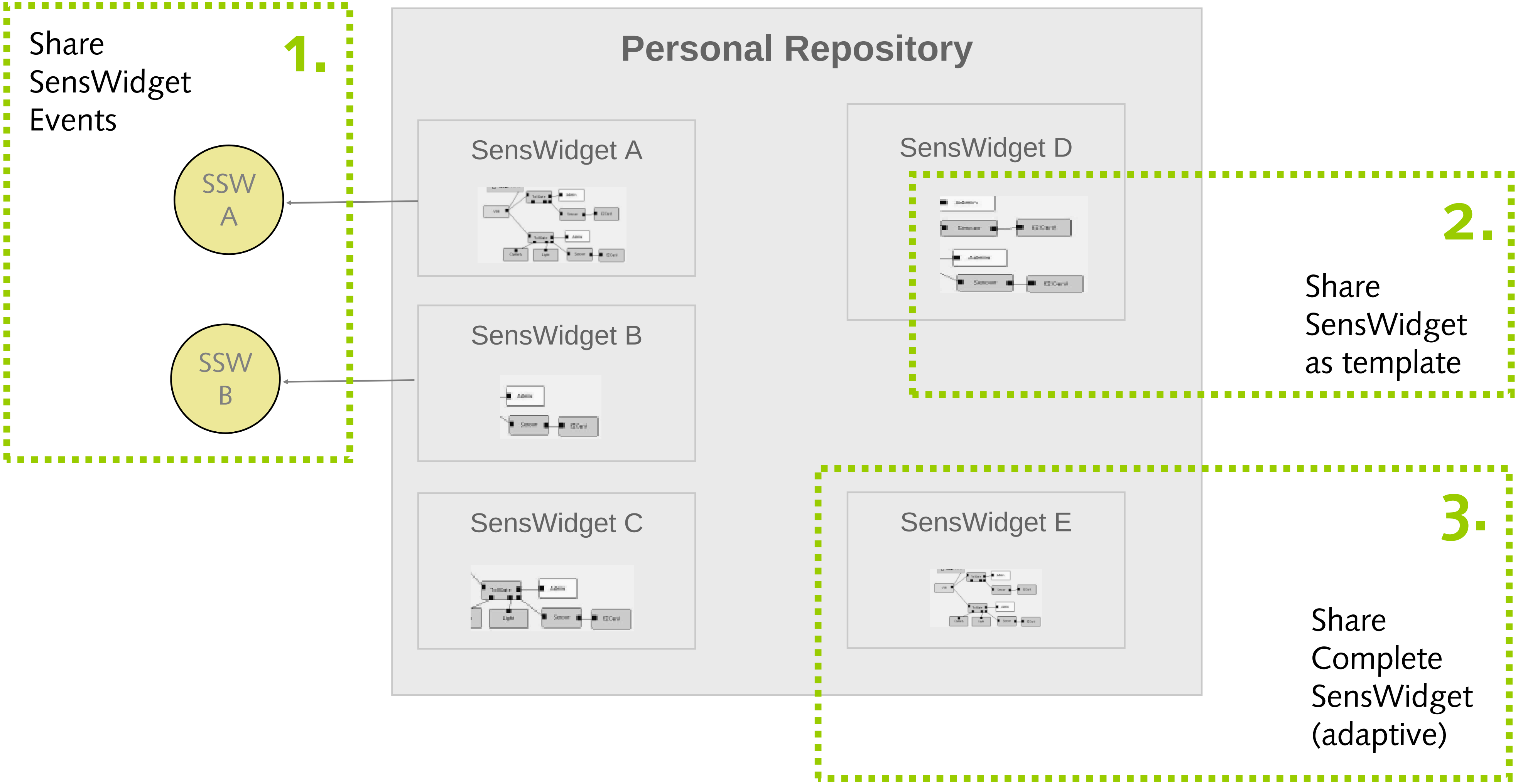
Editor

Control

Project
Components: Eclipse,
Time, Counter, Email
🟩
Edit
☑ Active

Home Activity
Components: ESBMove,
Filter, Light, ActorColor
🟥
Edit
☐ Active

Sharing and Templates (1)



1\.

Share SensWidget Events

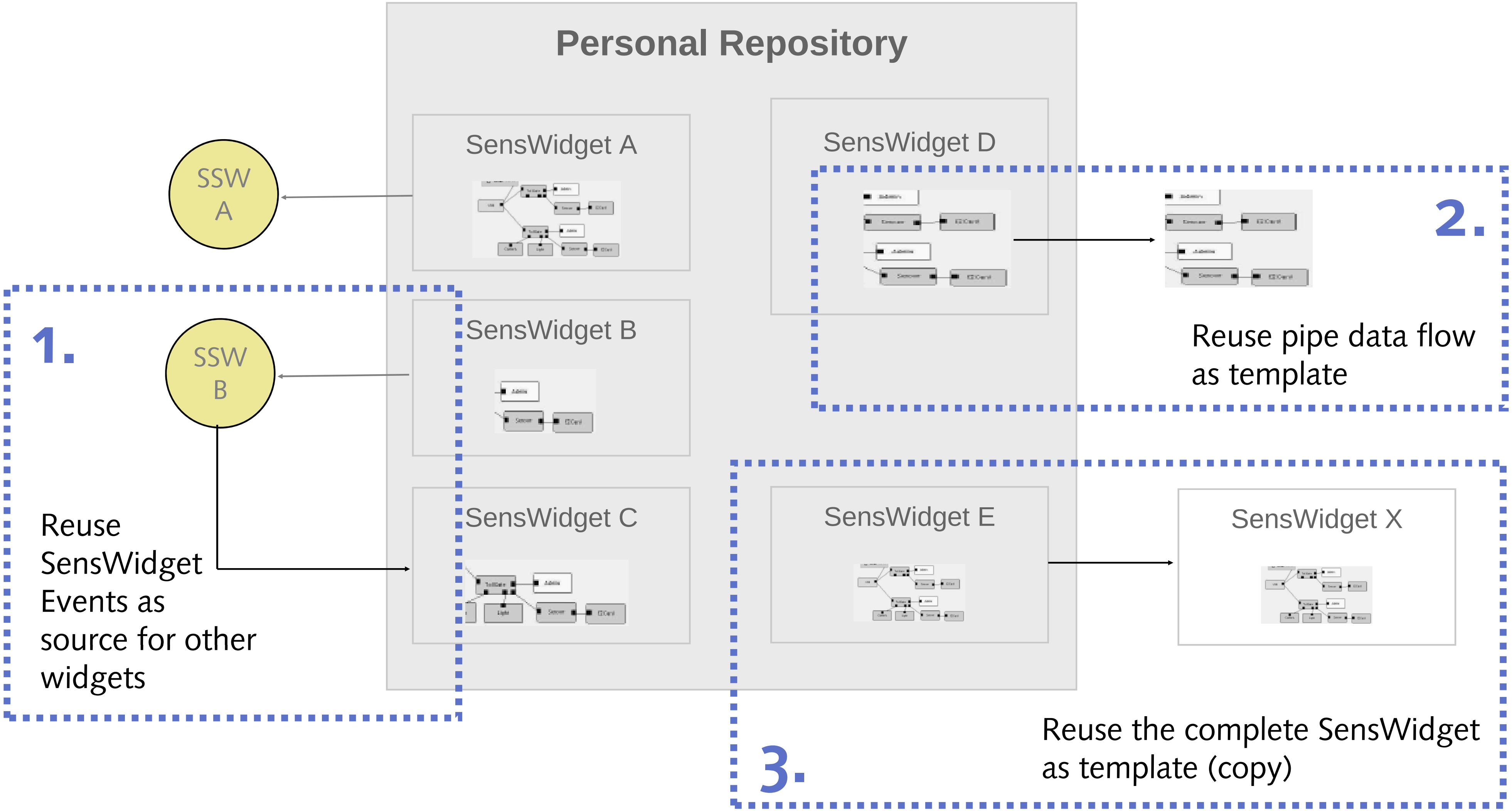
2\.

Share SensWidget as template

3\.

Share Complete SensWidget (adaptive)

Sharing and Templates (2)



Personal Repository

SensWidget A

SensWidget B

SensWidget C

SensWidget D

SensWidget E

SensWidget X

SSW A

SSW B

1. Reuse SensWidget Events as source for other widgets

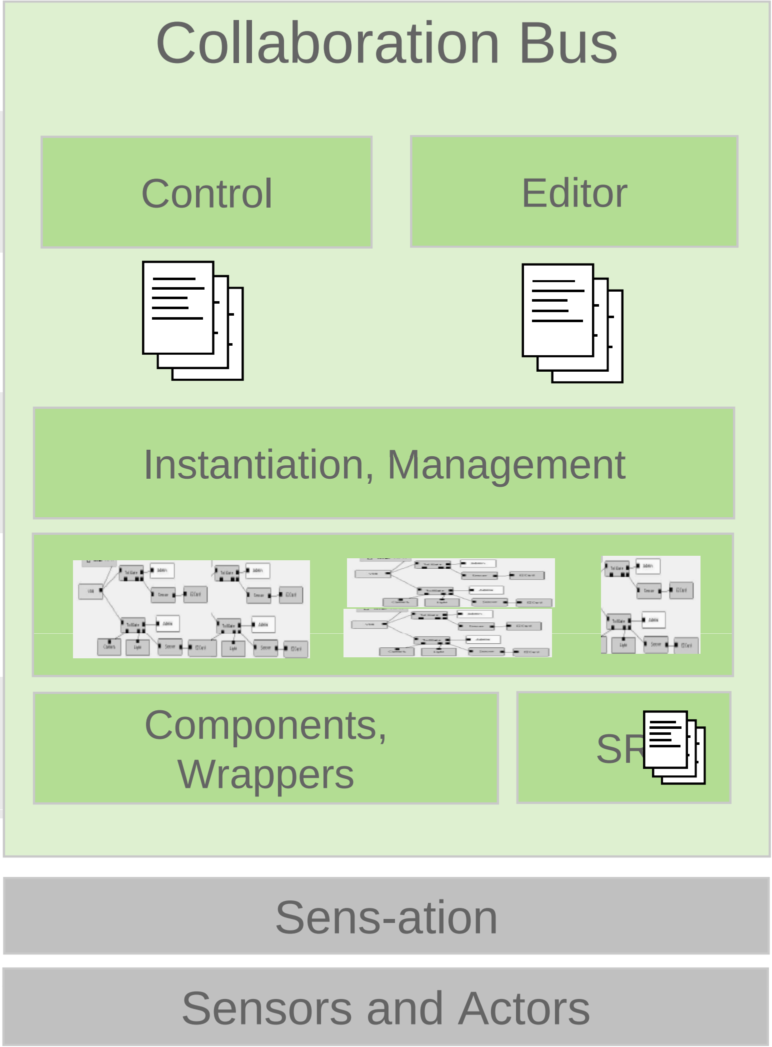
2. Reuse pipe data flow as template

3. Reuse the complete SensWidget as template (copy)

Layers

Structured into separate layers:

- Presentation layer: editor and personal repository
- Data exchange: description of current data flows and parameters
- Instance layer: creating components of the inference processing
- Personal Repository: individual SensWidgets, running threads
- Global repository: sharing, components, wrappers, etc.



Collaboration Bus

Control

Editor

Instantiation, Management

Components, Wrappers

SR

Sens-ation

Sensors and Actors

Concept Overview

Key features of "Collaboration Bus":

1. *Personalized:* Instead of using only a few predefined and generic operational networks we use quite a number of **highly personalized sensor-actor-relations**
2. *Overview and control:* Let the user control (start, stop) and edit his own created relations
3. *Easy and fast:* these sensor-actor-relations have to be defined and executed in a few minutes (seconds)
4. *Sharing knowledge:* for cooperative work, users can share their sensor-actor-relations (adaptive modules)

Implementation

Terms and definitions:

- **Task (Procedure, Workflow):** This is the activity the user want to implement with his tools (infrastructure)
- **Data Flow:** the stream of data between source and sink, passing several processing steps
- **Pipe:** connection between two components
- **Component:** source, sink and filter
- **Composition (network, graph):** directed graph of connections between data sources, sinks and filters, and with specification of their relations
- **Filter (operator):** conditions, operations, calculations, data processing, enrichment with meta data
- **SensWidget:** encapsulated composition with additional features, especially for sensor-actor-relations

Implementation

Project Parts (Sub Projects):

		Complexity:
1.	**Instantiation:** The composites of sources, filters, operators and sinks, local or remote objects, dynamic creation (from XML)	++++
2.	**Composition:** User interface, editor, support for creating new SensWidgets	++++
3.	**Control:** Personal repository, updates, start editor, summary, instantiate modules	++
4.	**Actors:** Actor elements, display, hardware, XML description, handling in Sens-ation server, ActorBridge	+++
5.	**Language:** Description language for sensor-actor-data-flow, networks, operators, parameter	+++
6.	**Further Sens-ation Extensions:** Extensions of the sensor XML description, actor integration, metadata, SensorValue extensions (pipes), personalization, *user right management, security*	+++

Technology

- Filter and pipe design pattern: processing components as filters, thread-safe pipes (FIFO) for data transfer, most of the components multi-threaded
- Abstract classes and interfaces: actor, source, pipe, filter
- Dividing of smaller processing steps into command objects; reusable command collections
- Composites (GoF) of components: filter with hierarchical structure
- Each component with an GUI representation: display method and also for dynamic set of parameters (reflection)
- Boolean operators for AND and OR conditions between pipelines
- Transformation between the main data types (int, boolean, String)
- Two implementations of filters and operators:
  - Multi-threaded objects for independent processing nodes
  - Entries in the command set collection (composite), especially for pre-processing of the values before they enter the pipes network (e.g. normalize, threshold, cut)

Filters and Operators

- Processing node of the pipeline (implement source and sink interface)
- Adaptive; include sensor parameters (e.g. normalize)
- Operator types (nodes):
  - **Numeric:** e.g. threshold, gate, counter, average, normalize, cut
  - **Binary:** e.g. gate, convert
  - **Text:** e.g. match, match list, convert, length, regular expressions
  - **XML:** e.g. contains node, compare, parameters, text search, other string filters, count entries, root object, match DTD
  - **General:** e.g. event counter, collector (reports), time gate, multiple translations between the data types, database lookup, sensor, delay
- Message generator for reports or summary (includes sensor and context details)

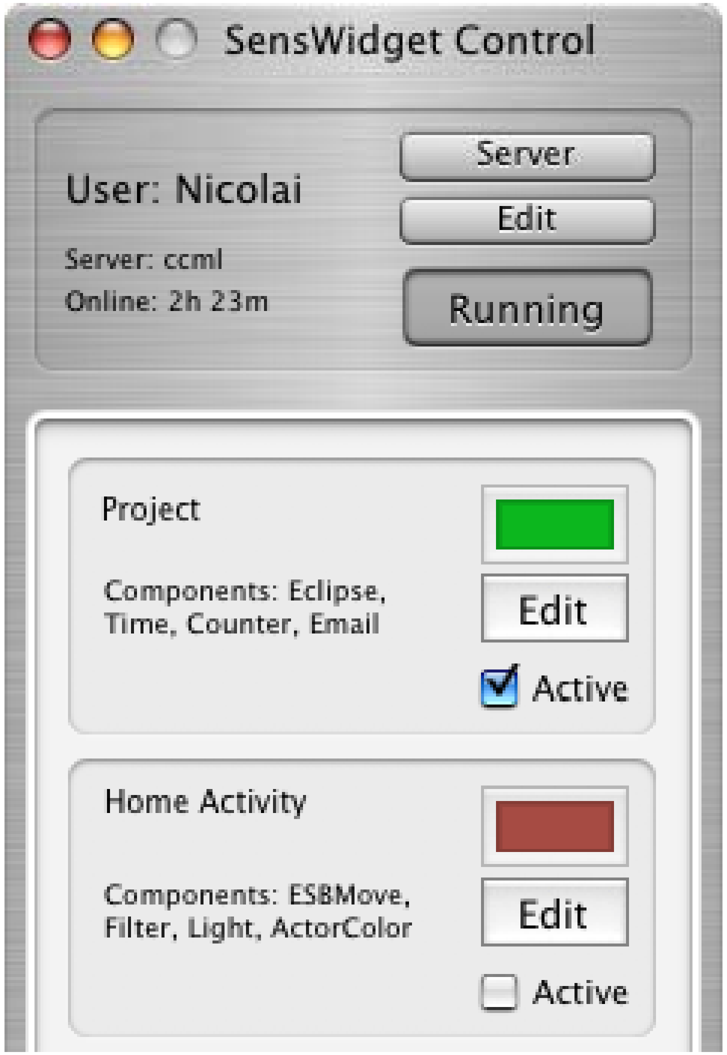
Actors

- Set of hardware and software actor modules (connected via adapters)
- Actor collections: ActorBridge
- XML description for registration:
  - 1 x Callback connection, location, availability, other parameters
  - N x Command + Parameter: executes action of the actor
- Examples of the actors set:
  - Software: Email, RSS feed, application starter (e.g. AppleScript Lib), visual notify (e.g. dockbar), IM daemon sends message
  - Hardware: controllable power plugs, IR commands, acoustic notification, SMS message
- Types of messages: event, report, summary, collection

Interface Design Studies

1. Control Interface:

- Overview of created sensor-actor-relations (SensWidgets)
- SensWidget operations: start, stop, edit, delete, add
- See current state of all Widgets
- Start and stop complete repository
- Additions: sharing options panel, external flow definitions



SensWidget Control

User: Nicolai

Server: ccml

Online: 2h 23m

Project

Components: Eclipse, Time, Counter, Email

☑ Active

Home Activity

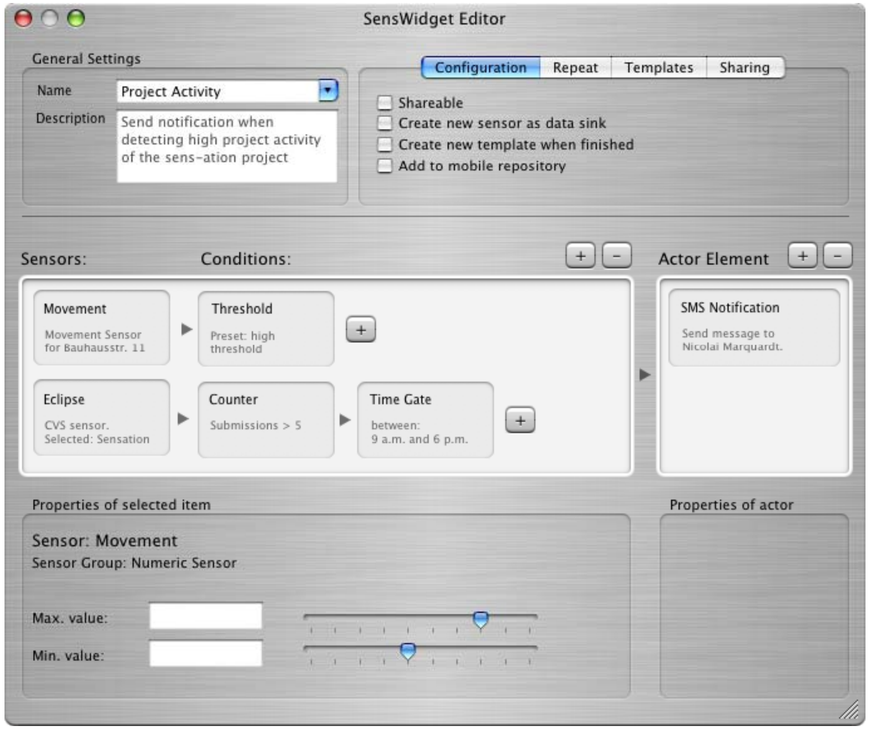
Components: ESBMove, Filter, Light, ActorColor

☐ Active

Interface Design Studies

2. Editor Interface:

- Create a new SensWidget
- Upper screen: name, description, configuration, repeating, templates and sharing options
- Create data flow conditions: select sensor, configure sensor, add conditions and finally select actor



SensWidget Editor

General Settings

Name: Project Activity

Description: Send notification when detecting high project activity of the sens-ation project

Configuration | Repeat | Templates | Sharing

☐ Shareable
☐ Create new sensor as data sink
☐ Create new template when finished
☐ Add to mobile repository

Sensors: | Conditions: | Actor Element

Movement – Movement Sensor for Bauhausstr. 11 ▶ Threshold – Preset: high threshold

Eclipse – CVS sensor. Selected: Sensation ▶ Counter – Submissions > 5 ▶ Time Gate – between: 9 a.m. and 6 p.m.

▶ SMS Notification – Send message to Nicolai Marquardt.

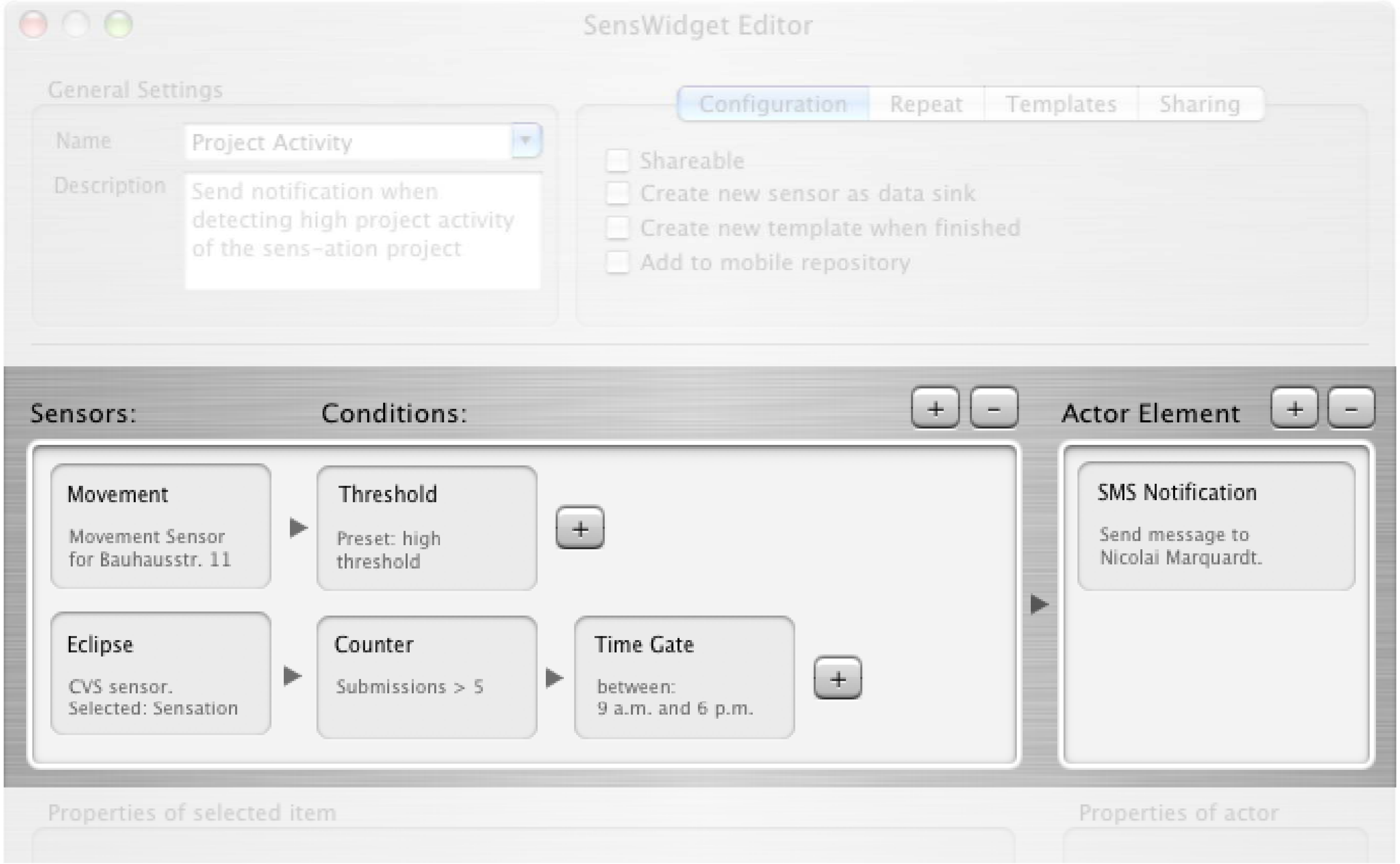
Properties of selected item

Sensor: Movement
Sensor Group: Numeric Sensor

Max. value:
Min. value:

Properties of actor

Interface Design Studies



SensWidget Editor

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Sensors:

Conditions:

Actor Element

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▶ SMS Notification: Send message to Nicolai Marquardt.

Properties of selected item

Properties of actor

Using SensWidgets

- Repeated actions, loops (e.g. weekly report, awareness, home environment control)
  - More complex compositions
  - Also use of multiple pipes and inference engine modules

- Only once and reject (e.g. notification of an awaited event, contact a person)
  - Short pipelines
  - Often using templates and copy mechanism
  - Specify max. execution time

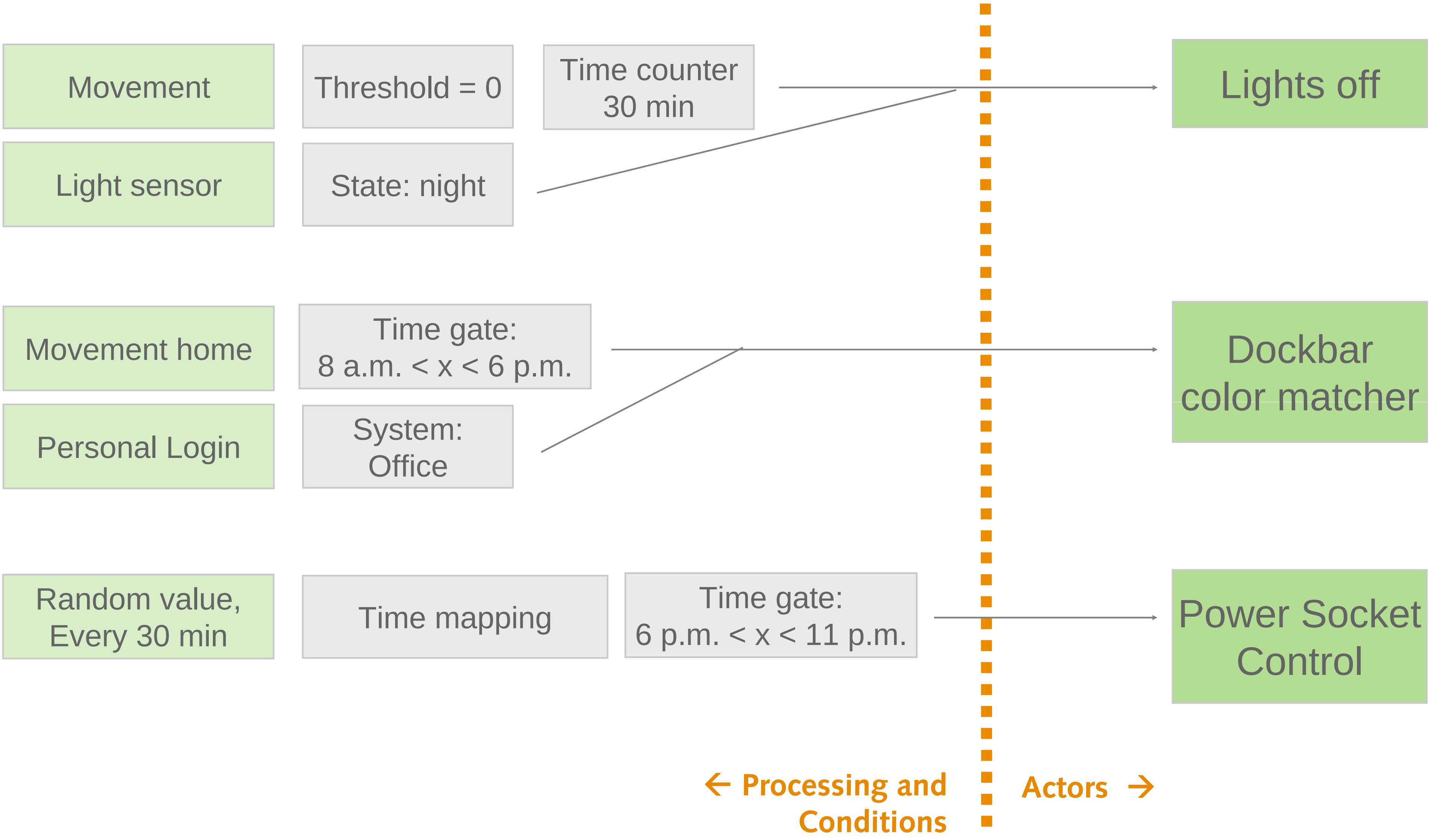
- Multiple time execution, manual select (e.g. project messages, state)
  - Specify execution conditions (e.g. with filter element

Using SensWidgets

- Ubiquitous Computing, private usage:
  - Control the home environment
  - Awareness of peoples activities
  - Device associations
  - Remote control
  - Reminders

- Computer Supported Cooperative Work, business usage:
  - Contact colleagues (with the option to select the most convenient point of time)
  - Project reports (from various sources)
  - Awareness of project participants

Example Scenarios: UbiComp



Movement | Threshold = 0 | Time counter 30 min → Lights off

Light sensor | State: night

Movement home | Time gate: 8 a.m. < x < 6 p.m. → Dockbar color matcher

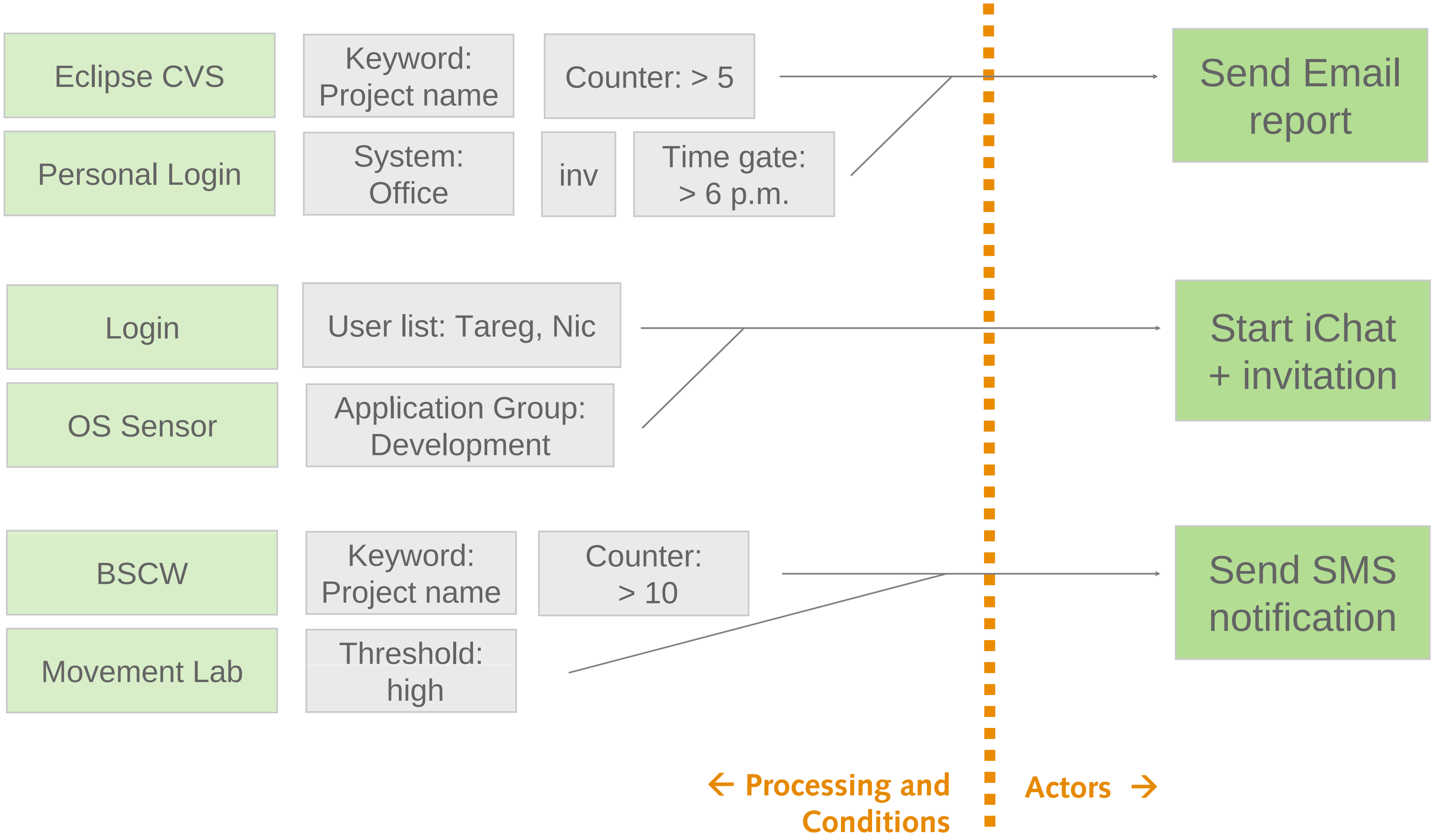
Personal Login | System: Office

Random value, Every 30 min | Time mapping | Time gate: 6 p.m. < x < 11 p.m. → Power Socket Control

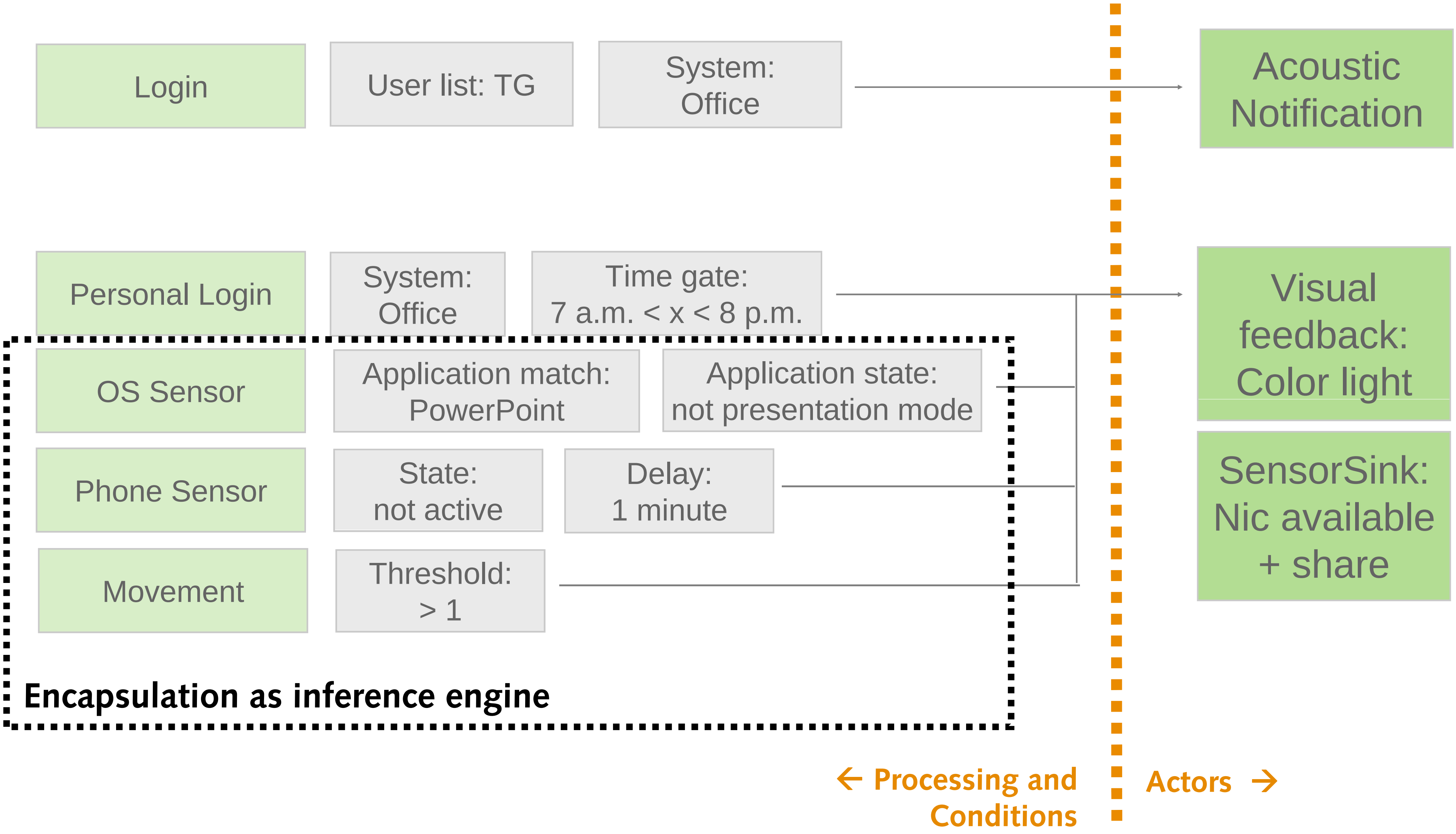
← Processing and Conditions

Actors →

Example Scenarios: CSCW (1)



Example Scenarios: CSCW (2)



Login

User list: TG

System: Office

Acoustic Notification

Personal Login

System: Office

Time gate: 7 a.m. < x < 8 p.m.

Visual feedback: Color light

OS Sensor

Application match: PowerPoint

Application state: not presentation mode

Phone Sensor

State: not active

Delay: 1 minute

SensorSink: Nic available + share

Movement

Threshold: > 1

Encapsulation as inference engine

← Processing and Conditions

Actors →

Conclusion

- User interface and control of light-weight SensWidgets
- Easy-to-use editor, reusable components, templates
- Sharing for collaboration
- Flexible underlying technology layer: XML, dynamic component composition, transferable
- Personal repository, overview and control (local or remote located)
- Concept for the integration of Actors, and some sensor description extensions at the SensBase platform

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Thank you for your attention!

Nicolai Marquardt
Collaboration Bus Research Project

Cooperative Media Lab
Bauhaus University Weimar