Robot-Era: Work Package 4

Domestic Robotic Platform

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Technical Aspects of Multimodal Systems

November 16, 2012

Outline

Technical Tutorial

- [9:00] Welcome to the tutorial
- [9:15] Introduction on tutorial and agenda
- [9:30] Jaco arm control with ROS
- [10:30] Break & Informal Discussion
- [11:00] Simulation: Scitos, Jaco and working with Gazebo
- [12:30-13:30] Lunch & Informal Discussion
- [13:30] MIRA-ROS Adapter
- [15:00-15:30] Break & Informal Discussion
- [15:30-17:00] Controlling PTU, Camera and ASUS (Kinect) Face Recognition
- [overflow] Extended simulation demo, RACE demo (PR2), PR2 object manipulation demo

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Technical Tutorial (cont'd)

- Jaco arm control with ROS
  - Introduction on Jaco arm
  - C#-library API
  - ROS stack overview
    - API
    - jaco state publisher
    - topics and message format
  - Outlook
  - Demo

Technical Tutorial (cont'd)

- Simulation: Scitos, Jaco and working with Gazebo
  - Gazebo overview
  - Overview of Scitos URDF and Gazebo model
  - Demo
  - *Outlook
  - *Discussion about scenarios (robot handover, HRI, human simulation)

Technical Tutorial (cont'd)

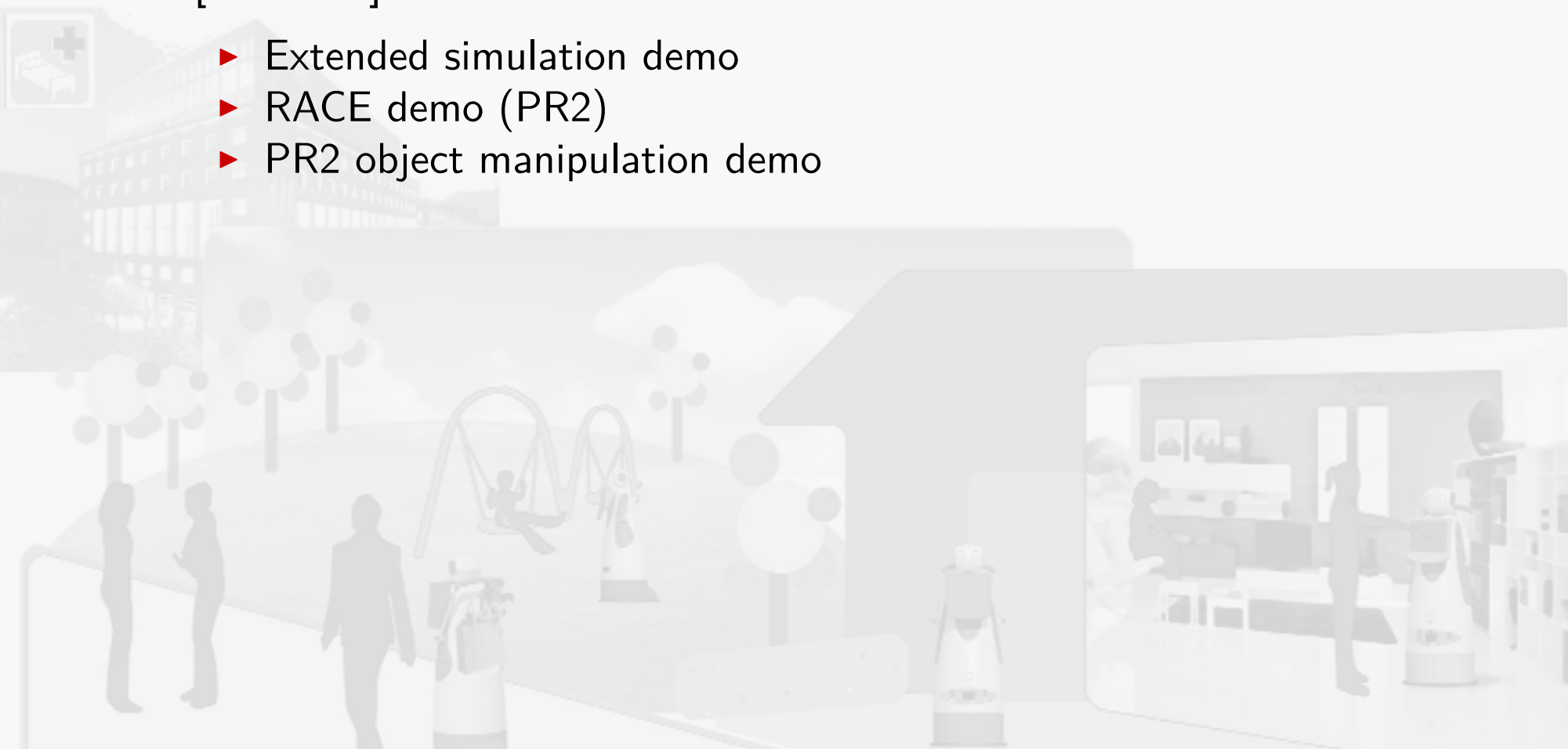
- MIRA-ROS Adapter
  - Intorduction to MIRA and ROS concepts
  - Comparison (MIRA-ROS)
  - Aproach for the Adapter
  - Outlook

Technical Tutorial (cont'd)

- Controlling PTU, Camera and ASUS (Kinect), Face Recognition
  - Introduction on PTU, Camera, ASUS
  - Present work on Camera
  - Demo (Camera, *PTU, Face Recognition)

Technical Tutorial (cont'd)

- [overflow]
  - Extended simulation demo
  - RACE demo (PR2)
  - PR2 object manipulation demo



Outline

Activities

- *Specifications and middleware architecture of the domestic robotic platform* (D4.1, within Workgroup 1)
  - technical communicating with robot arm suppliers
  - HW + SW integration design
- ROS tabletop segmentation + manipulation
  - Using ROS object_manipulation stack
  - using ROS arm_navigation stack
    - integration of the OPML planner[1] (obstacle avoidance, IK)
    - integration of MoveIt![2] (motion planner, arm configuration)

[1] http://www.ros.org/wiki/ompl
[2] http://moveit.ros.org/

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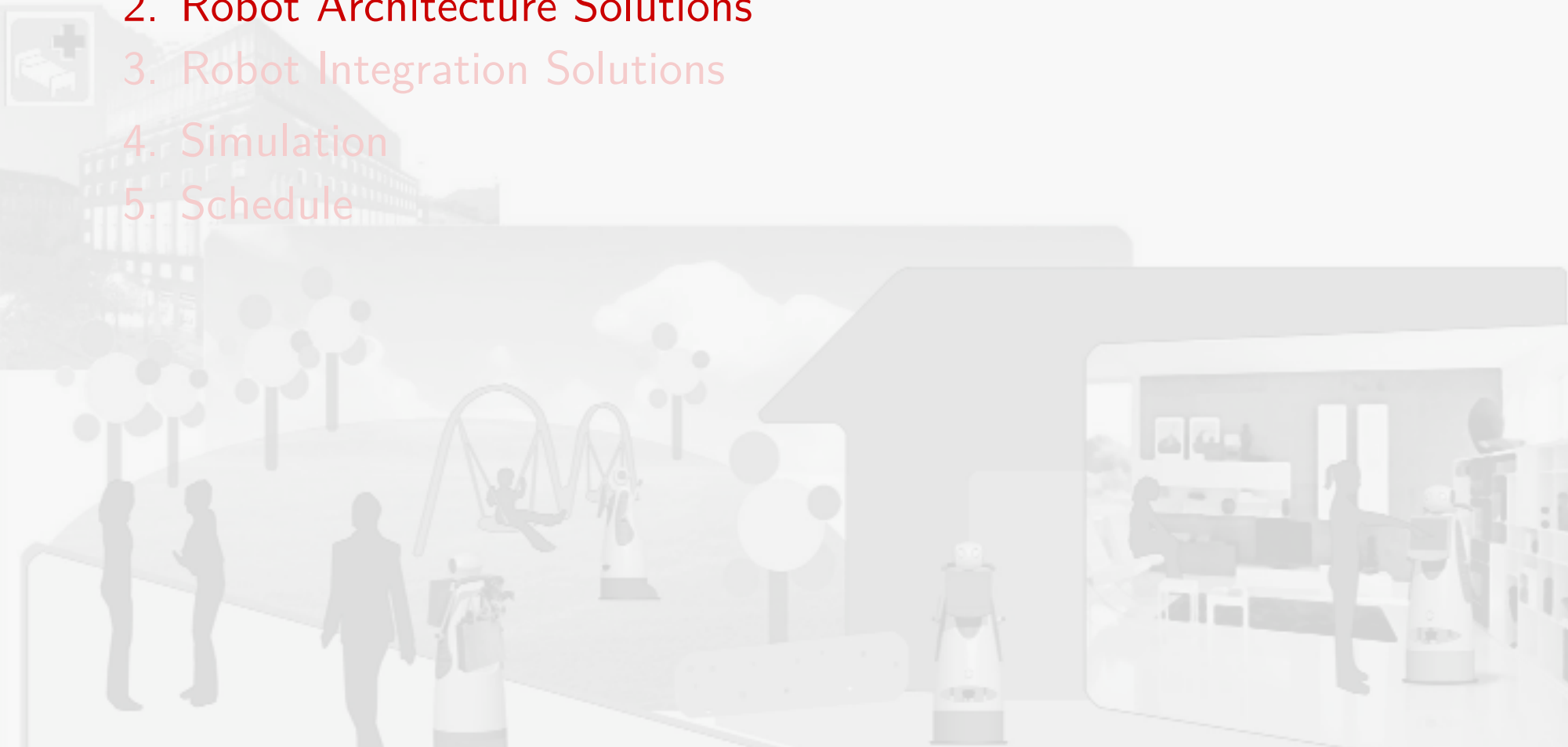
Activities (cont'd)

- Other sensors (Camera, PTU)
- Mira-ROS Adapter
- Simulation and Robot Model
- Using experience from FP7 project *RACE*, which involves
  - (3D) obstacle avoidance
  - navigation + localization
  - (simple hierarchical) task planning (JSHOP2)
  - parallel task execution
  - tabletop segmentation (and object detection)[3]
  - object recognition (via household database)

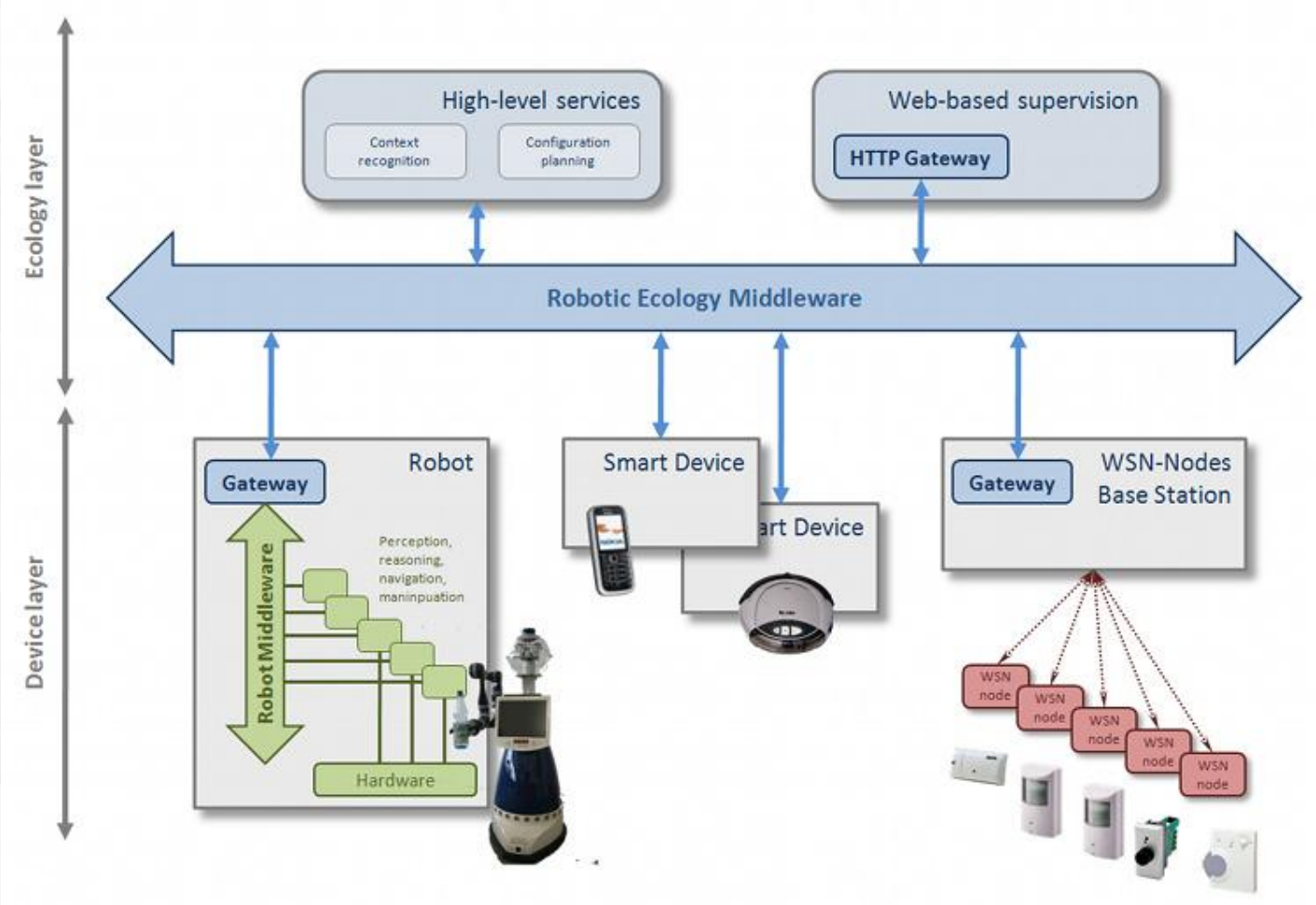
[3] http://youtu.be/WKL_AkyU8MQ

Outline



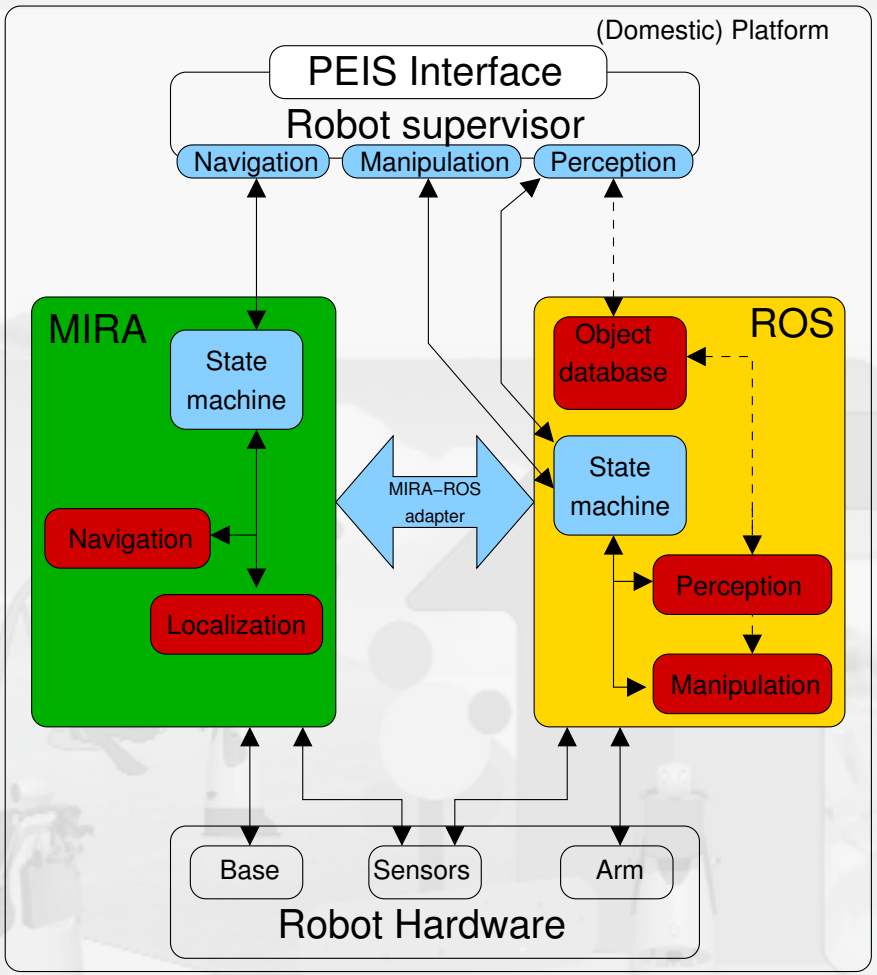
Architecture

Robot-Era System



Architecture (cont'd)

Domestic Platform



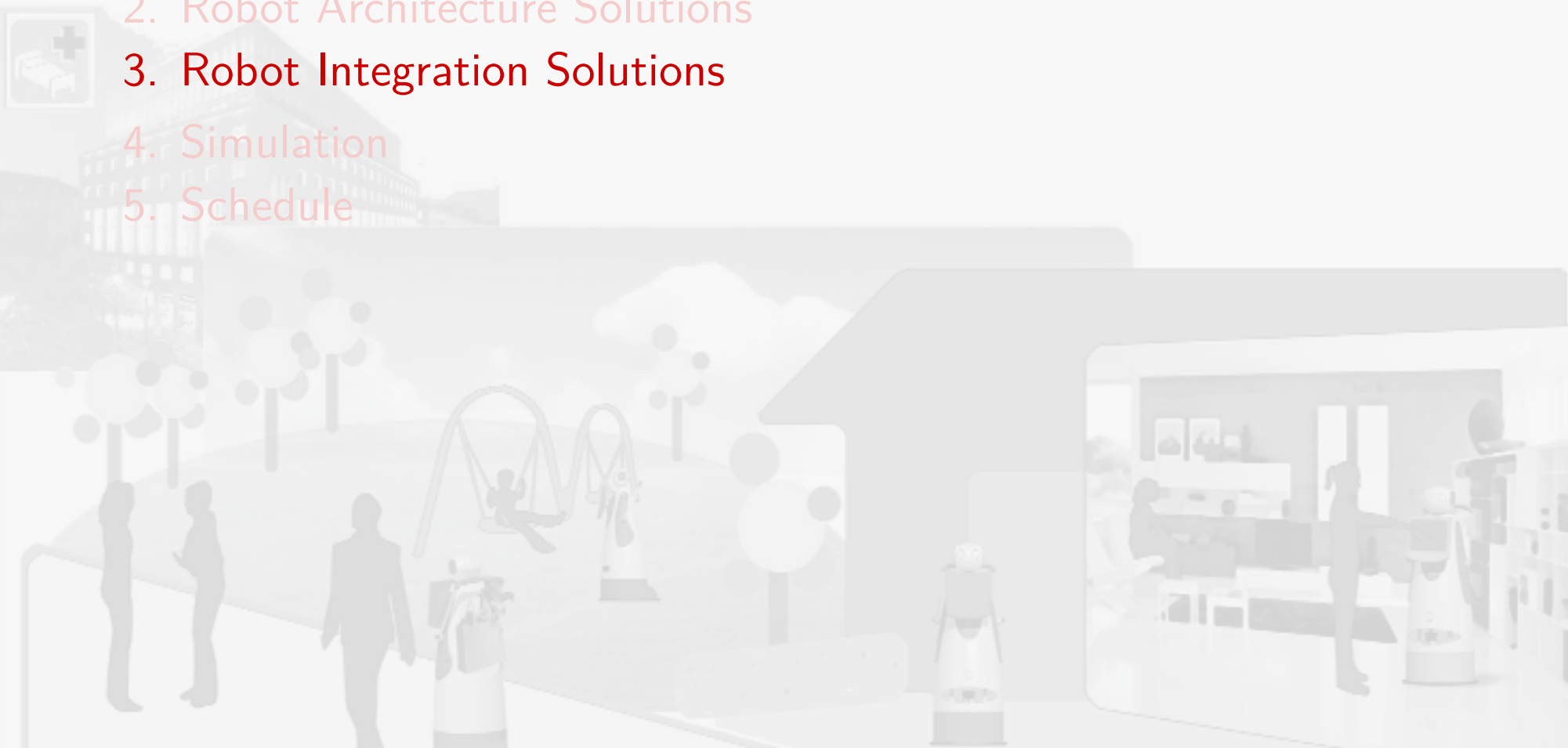
Architecture cont'd

- *GUI* for supervision, debugging, test controlling
- *PEIS* is the the interface to the PEIS Ecology
- *Planner* subsumes tasks into subtasks and re-plans if something fails (included in PEIS?)
- *Database* holds information about objects in order to recognize them (interfaced by the ROS tabletop stack)
- *State machine* (ROS) will be realized by the SMACH (ROS python) library

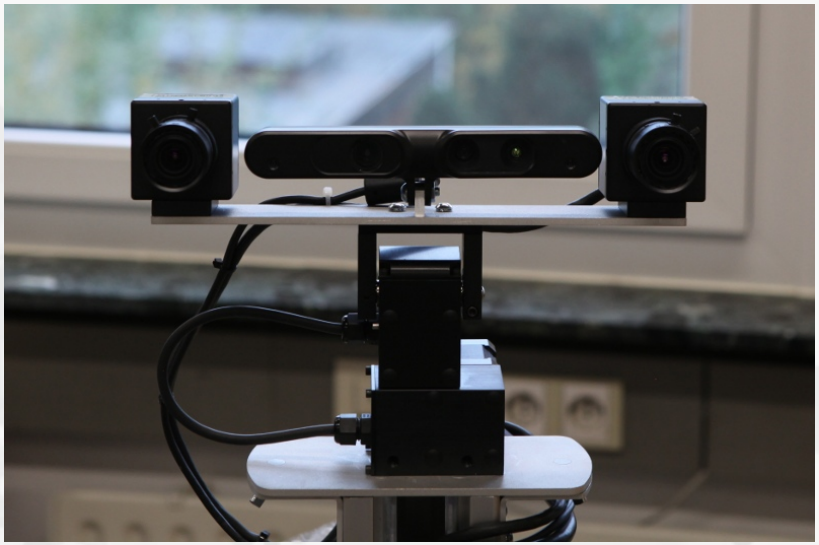
Architecture cont'd

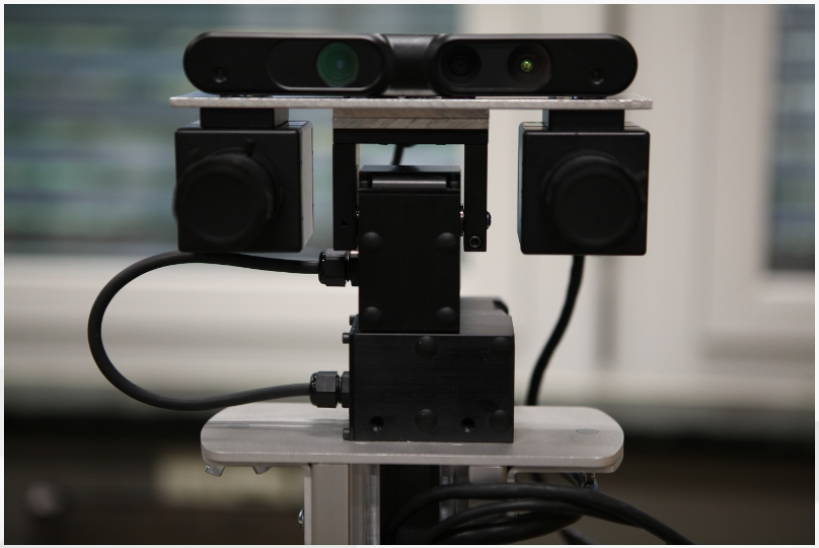
- *Perception* (ROS) includes ROS tabletop recognition and table detection and is available
  - sensory data will be retrieved by the ASUS (Kinect)
- *Manipulation* (ROS) is available in the ROS manipulation stack
  - the Jaco Arm model is being integrated
- *Adapter* provides transparent communication between ROS and MIRA
  - translates between Services (RPC), Actions (Callbacks) and Messages

Outline



Scitos Head Integration





Robot Arm Kino Jaco cont'd

- ROS API available for Ubuntu (11.04) and ROS Electric (migrated to Fuerte and 12.04)
- basically a ROS wrapper for the (Windows) proprietary kinematic controller libraries
  - uses the Linux Mono project
- provides a 3D model for visualization in RViz
- controllable by setting each interpolation point's velocity
- official release of the ROS driver is planned for autumn (Sep-Dec?) 2012
- driver development is done at a German university and direct developer contact is possible

Issues

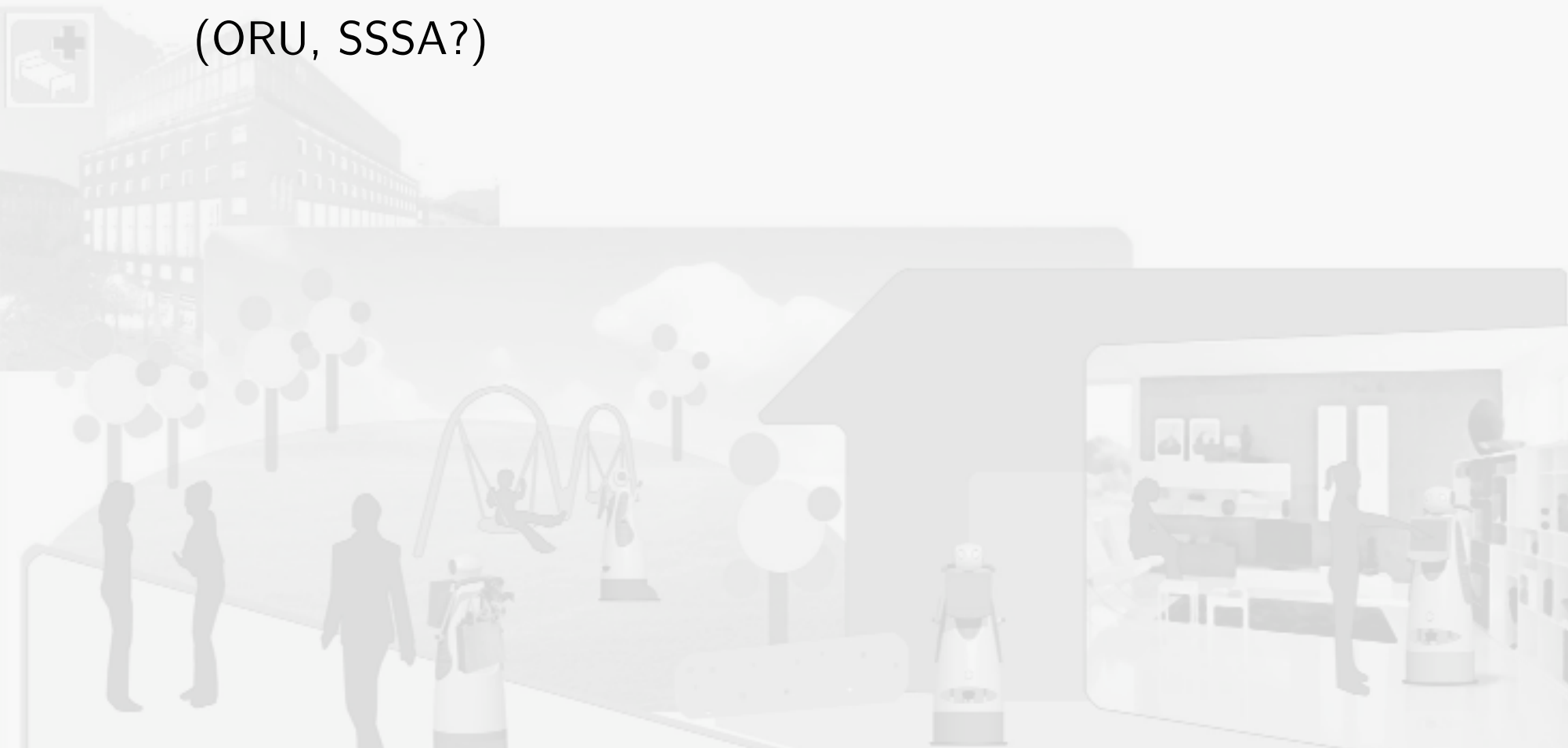
- 3D collision avoidance (without tilting laser)
- PEIS-ROS bridge needed

- Arm height of ca. 1.1 m might reduce collision free position when manipulation on the tabletop

Outline

ROS Gazebo Simulation

- will there be the test environment available as Gazebo world? (ORU, SSSA?)



Outline

Deliverables

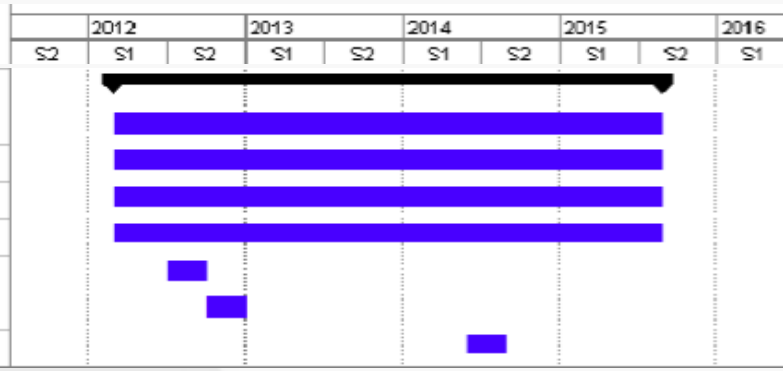
Delive-rable Number [61]	Deliverable Title	Lead benefi-ciary number	Estimated indicative person-months	Nature [62]	Dissemi-nation level [63]	Delivery date [64]
D4.1	Report on specifications and middleware architecture of the domestic robotic platform	7	8.00	R	CO	5
D4.2	First domestic robotic platform prototype for the first experimental loop	5	42.00	P	PU	15
D4.3	Final domestic robotic platform prototype for the second experimental loop	5	38.00	P	PU	32
D4.4	Report on the final domestic robotic platform and documentation about usage	5	4.00	R	PU	44
		Total	92.00			

Milestones

Milestone number [59]	Milestone name	Lead beneficiary number	Delivery date from Annex I [60]	Comments
MS2	Delivery of robotic platforms and AmI infrastructure prototype for the first experimental loop	1	15	
MS5	Delivery of robotic platforms and AmI infrastructure prototype for the second experimental loop	1	35	

Tasks

Nome attività
WP 4 - Domestic robotic platform (UHAM)
T 4.1 Set-up of the robotic platform for domestic environments
T 4.2 Design of control strategies for navigation
T 4.3 Design of control strategies for grasping and manipulation
T 4.4 Design of interfaces for Human Robot Interaction
T 4.5 Early prototype integration and implementation of functionalities
T 4.6 Preparation of the domestic robotic platform for the first experimental loop
T 4.7 Refinement and development for the second experimental loop



T4.1 Set-up of the robotic platform for domestic environments

UHAM, SSSA, MLAB, UOP, STM, M3-44

- integrate mobile platform, robotic arms and end-effectors (payload etc. according to WP2 criteria)
- integrate communication module (for connectivity with *AmI*)
- integrate additional sensors (stereo cameras, infra-red?)
- integrate HRI (touch screen, microphone, speakers, LED (see T4.4)
- integrate additional HW (handle, case, tray?)
- integrate security mechanisms (security buttons, bumpers)
- implement friendly, acceptable cover (see WP2)
- define middleware architecture

T4.2 Design of control strategies for navigation

MLAB, RT, SSSA, M3-44

- measure and integrate robot characteristics (shape, dynamics) into the navigation stack *(CogniDrive)*
- design people tracking and following
  - face tracking (OpenCV, pi_facetracker?)
  - motion tracking
- object trajectory prediction

T4.3 Design of control strategies for grasping and manipulation

UHAM, UOP, M3-44

- object detection via stereo-vision (Kinect), SIFT-feature, 3D laser ranger
- learning manipulation strategies (object ontology), handle unknown objects
- use results of hierarchical task network (HTN) planning algorithm
- image processing and detecting offline-trained common objects
- apply offline-learned grasps (later also online)
- integrate online learning manipulation and linguistic architecture (*UOP*)

T4.4 Design of interfaces for Human Robot Interaction

UOP, RT, M3-44

- investigate sophisticated HRI (via screen, e.g. emotional state, language)
  - wireless tablet with suited GUI?
  - control typical tasks, e.g. call robot, get out the trash bin, initiate plastic bag catching from shop etc.
  - provide information about the (ambient) sensor system to the user
- investigate natural language interaction
- explore Julius speech recognition system

T4.5 Early prototype integration and implementation of functionalities

UHAM, SSSA, UOP, MLAB, RT, M7-9

- integrate outcomes of previous tasks into robotic platform (navigation, manipulation, interaction, learning)
  - SW and firmware integration for different parts
  - Control strategy (high-level)

T4.6 Preparation of the domestic robotic platform for the first experimental loop

UHAM, MLAB, UOP, M10-12

- prepare robotic platform for experiments in Italy and Sweden
- shipping
- testing

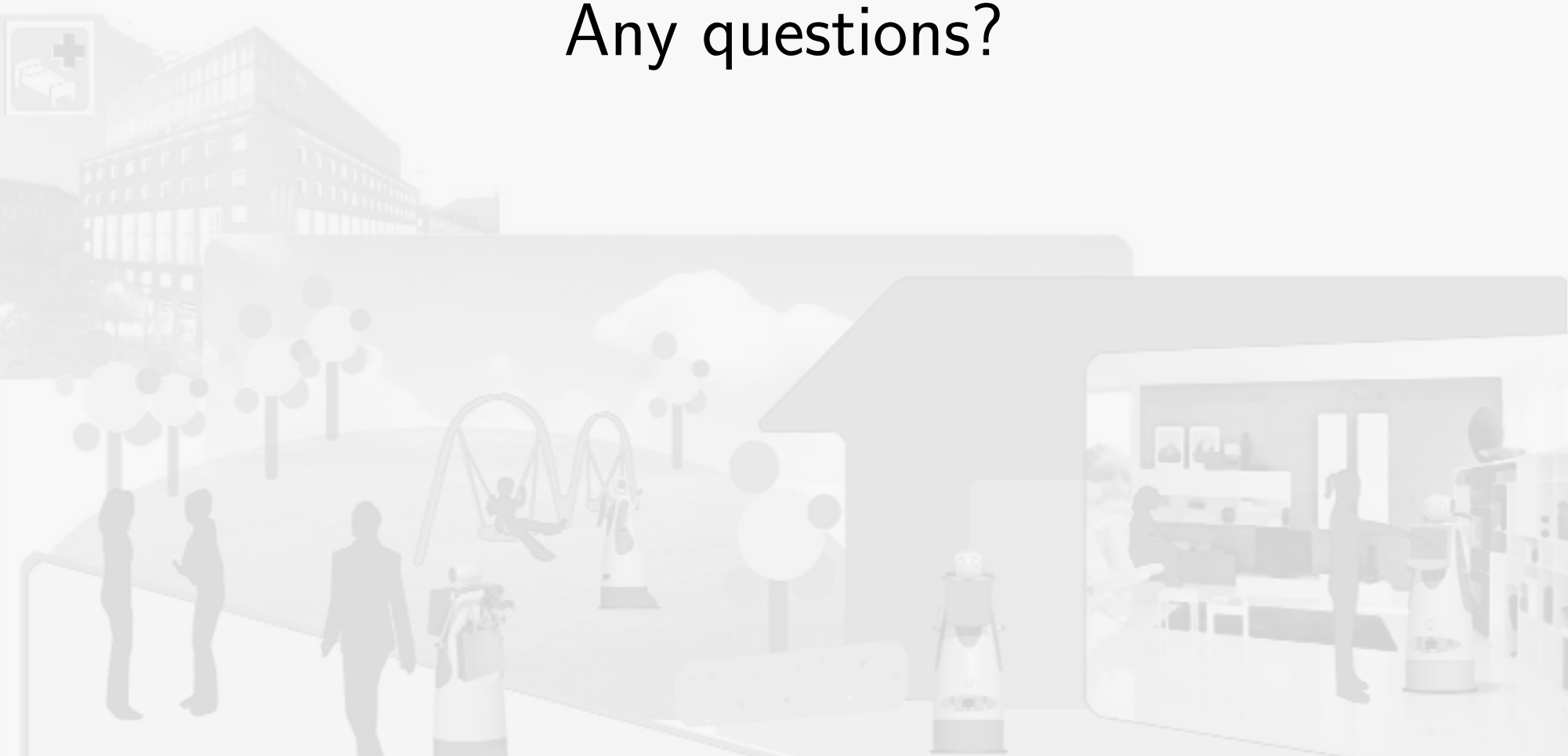
T4.7 Refinement and development for the second experimental loop

UHAM, UOP, M30-32

- integrate results of first experimental loop for improvements (T4.1-4.5)

Thank You!

Any questions?



Work Package Participation UHAM

Work Package	Person Month
1	1
2	2
3	2
4	44
5	2
6	2
7	6
8	6
9	2
10	5

Backup

- face recognition details