Understanding the RoboEarth Cloud
a party with smart owls, big elephants, and twisted snakes

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RoboEarth Quick Facts

- Objective: Building an Internet for Robots

- Funding: EU 7th Framework, ~4 mil. Euro

- 6 Partners: TUM, Uni. Stuttgart, TU/e, ETHZ, Uni. Zaragoza, Philips

RoboEarth

The RoboEarth Team

The Building Blocks of the RoboEath Cloud

- Language

- Storage

- Computation

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RoboEarth Language

M. Tenorth, A. C. Perzylo, R. Lafrenz, and M. Beetz, "The roboearth language: Representing and exchanging knowledge about actions, objects, and environments," in *Robotics and Automation (ICRA), 2012 IEEE International Conference on*, 2012, pp. 1284–1289.

RoboEarth Language - Challenges and Solutions

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How to represent?
KnowRob Ontology: OWL-based semantic representation

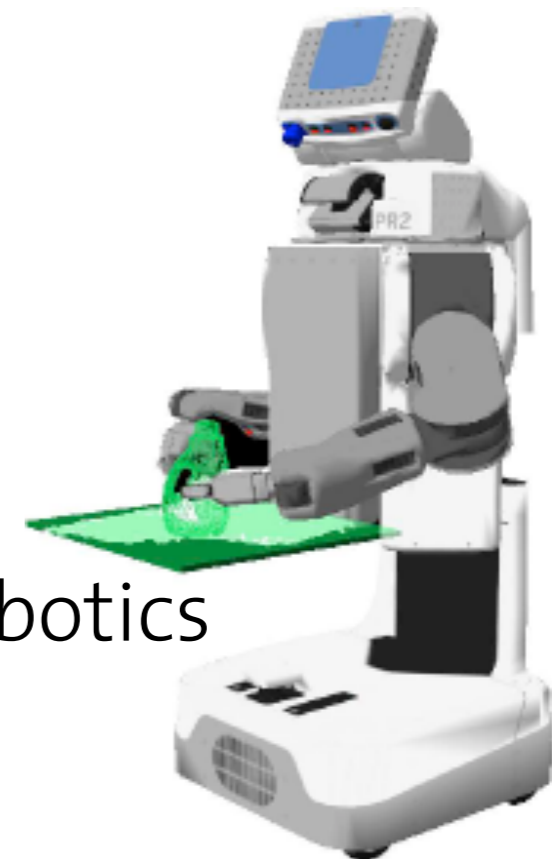**How to Reason?**
KnowRob: Knowledge Processing Framework

What to share?
Object Models
Environment Maps
Action Recipes

How to Execute?
CRAM: Cognitive Robotics abstract knowledge

for details visit: http://knowrob.org

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Action Recipes

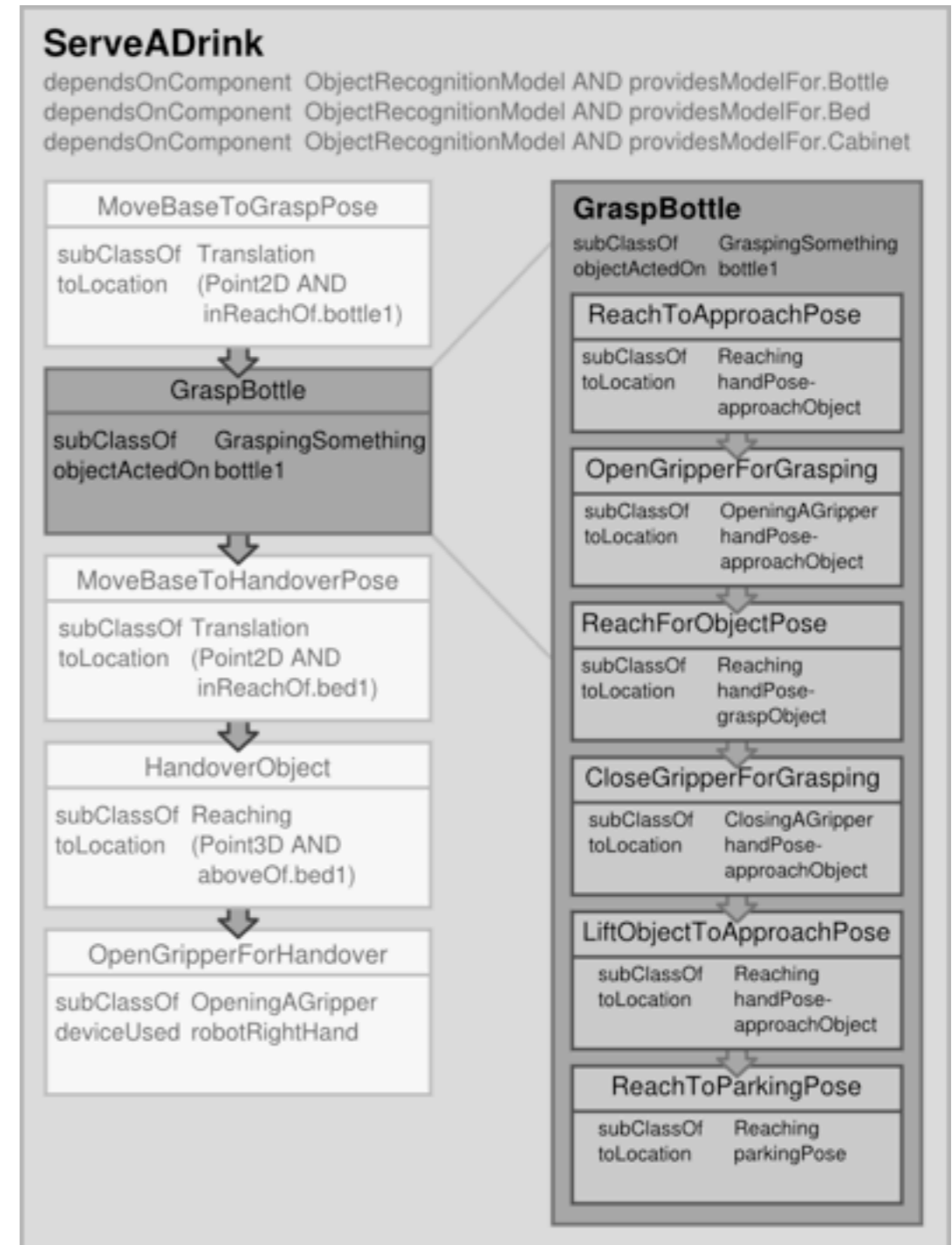**Neo**: [aiming at an helicopter] Can you fly that thing?

Trinity: Not yet. [picks the phone, calls Tank]

Trinity: Tank, I need a pilot program for a B-212 helicopter.

[Tank loads the program in Trinity's brain]

Trinity: [to Neo] Let's go.

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Representation-Action Recipes

- Highlights
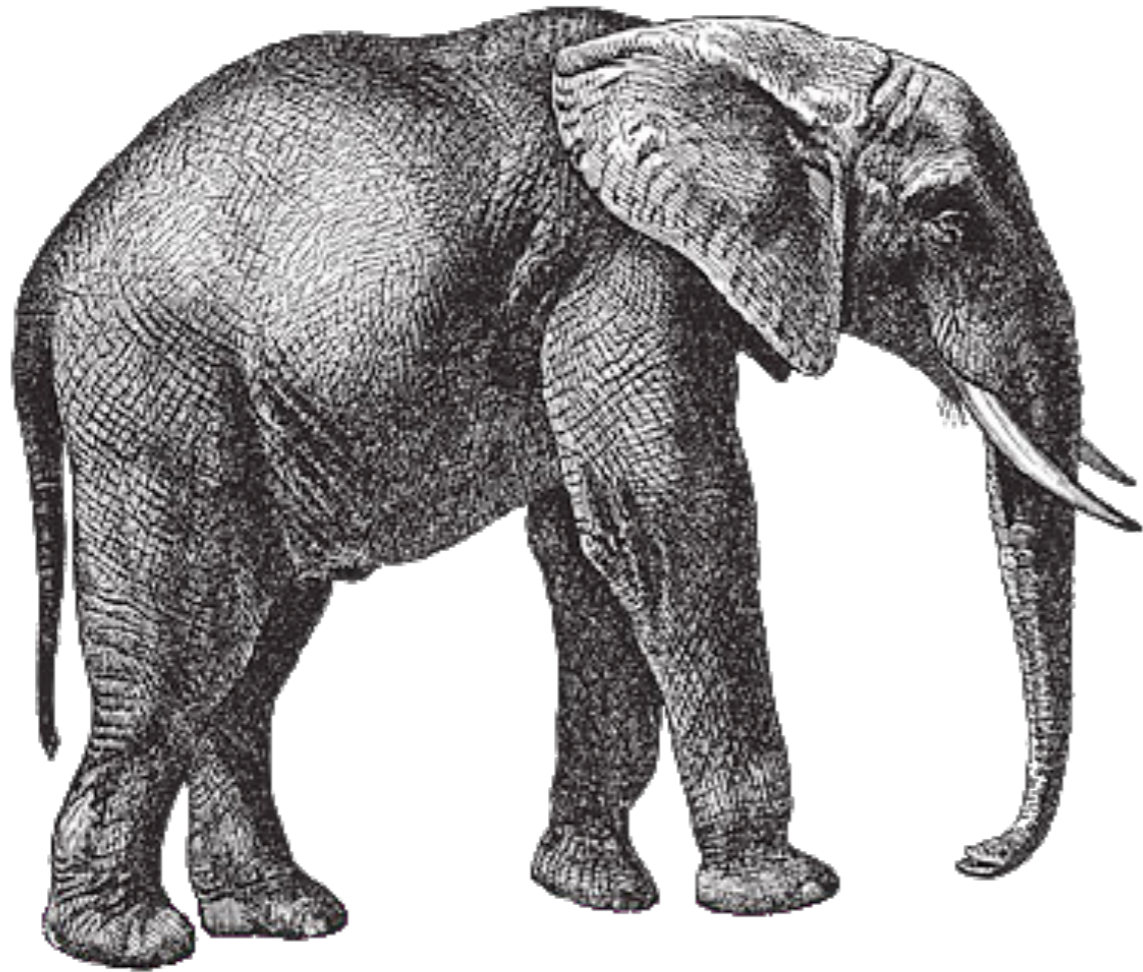 - Ability to reason about the applicability
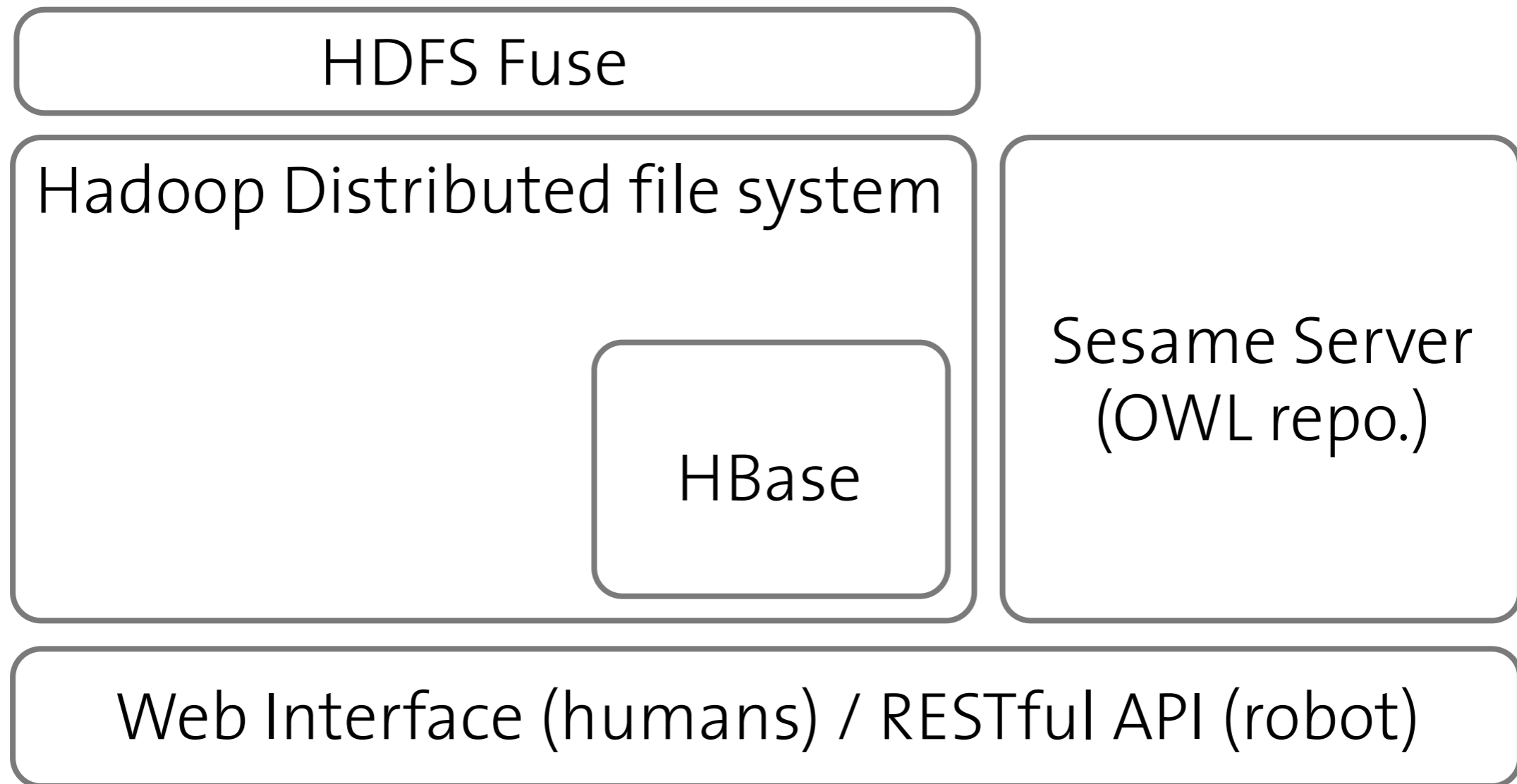 - Ability to adapt

Representation-Action Recipes-Demo
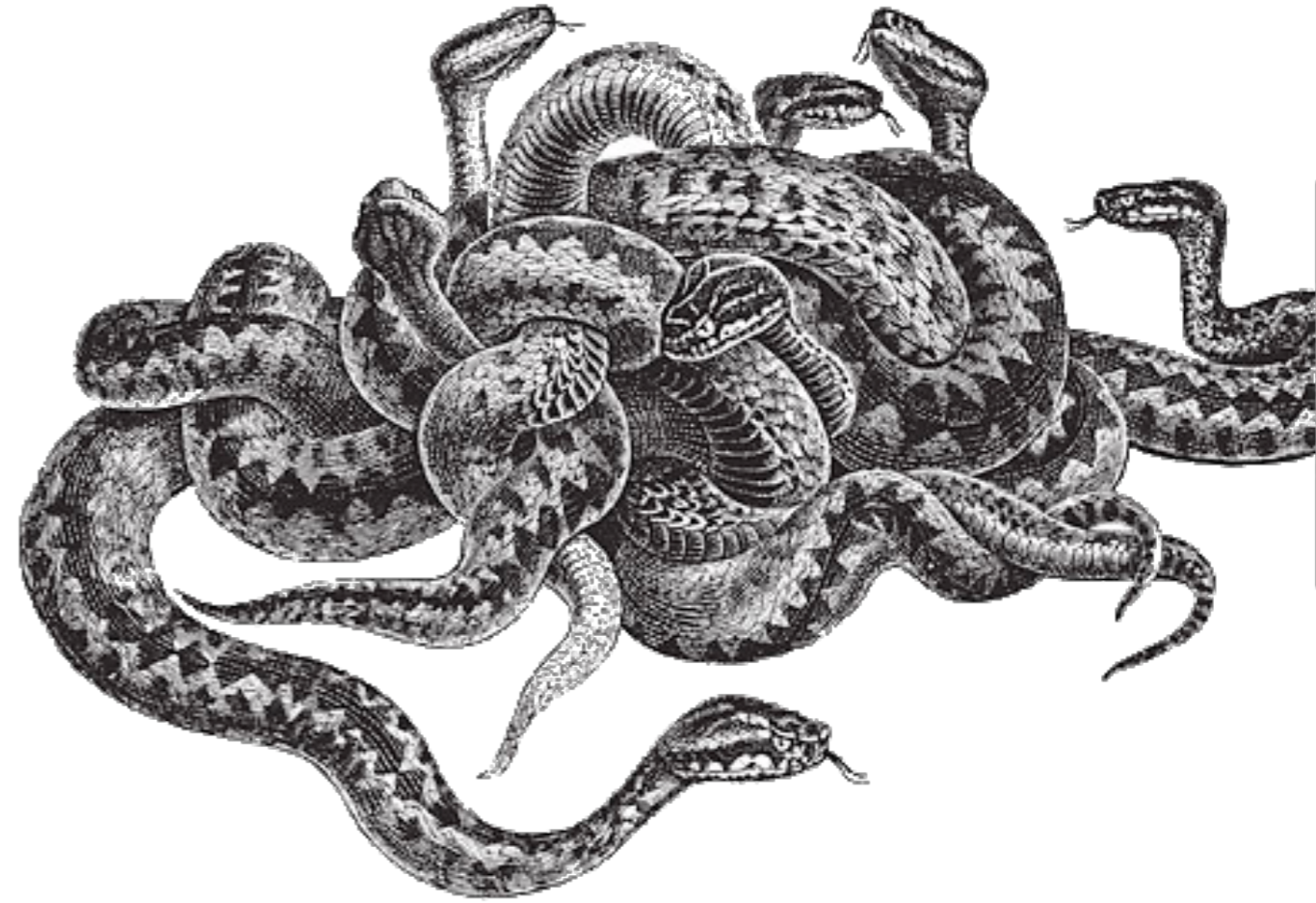

PR2 serves a drink using RoboEarth... 2x

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RoboEarth Storage

RoboEarth Storage

HDFS Fuse

Hadoop Distributed file system

HBase

Sesame Server
(OWL repo.)

Web Interface (humans) / RESTful API (robot)

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RoboEarth Cloud Engine
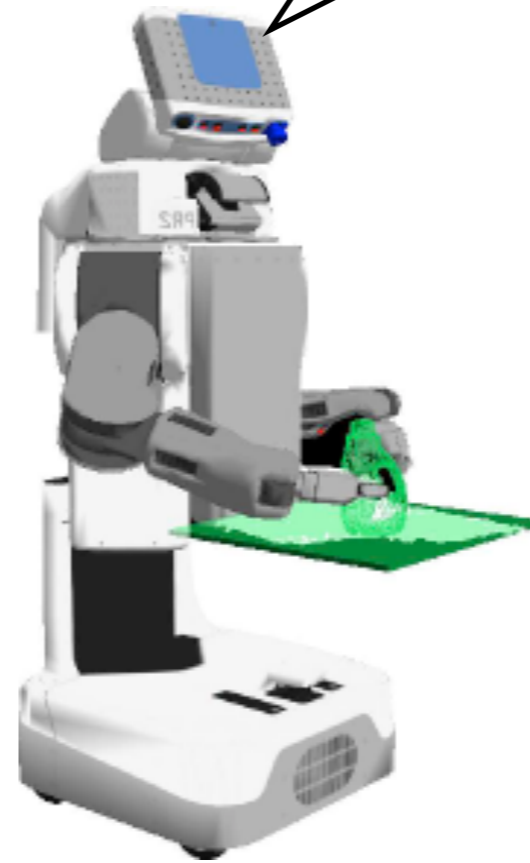## (a.k.a Rapyuta)

D. Hunziker, M. Gajamohan, M. Waibel, and R. D'Andrea, "Rapyuta: The RoboEarth Cloud Engine,"
in *Proc. IEEE Int. Conf. on Robotics and Automation (ICRA), Karlsruhe, Germany*, 2013.
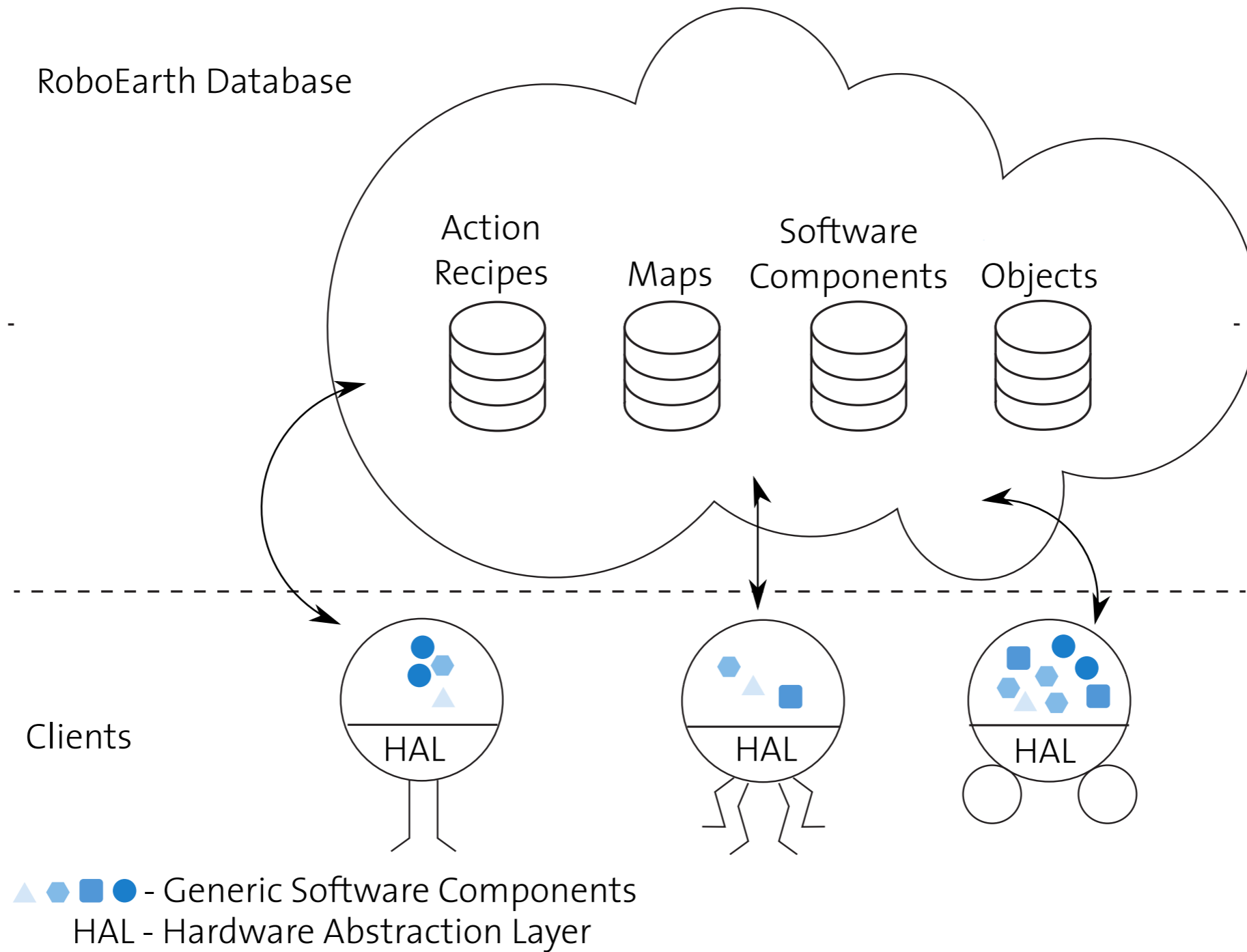
More challenges along the way...

Something missing?

RoboEarth Database

Action Recipes   Maps   Software Components   Objects

Clients

HAL   HAL   HAL

▲◆■● - Generic Software Components
HAL - Hardware Abstraction Layer

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The Complete Picture!

RoboEarth Database — Action Recipes, Maps, Software Components, Objects

RoboEarth Cloud Engine

Clients — HAL, HAL, HAL

△ ⬡ ■ ● - Generic Software Components
HAL - Hardware Abstraction Layer

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Turtlebot: Internet Edition
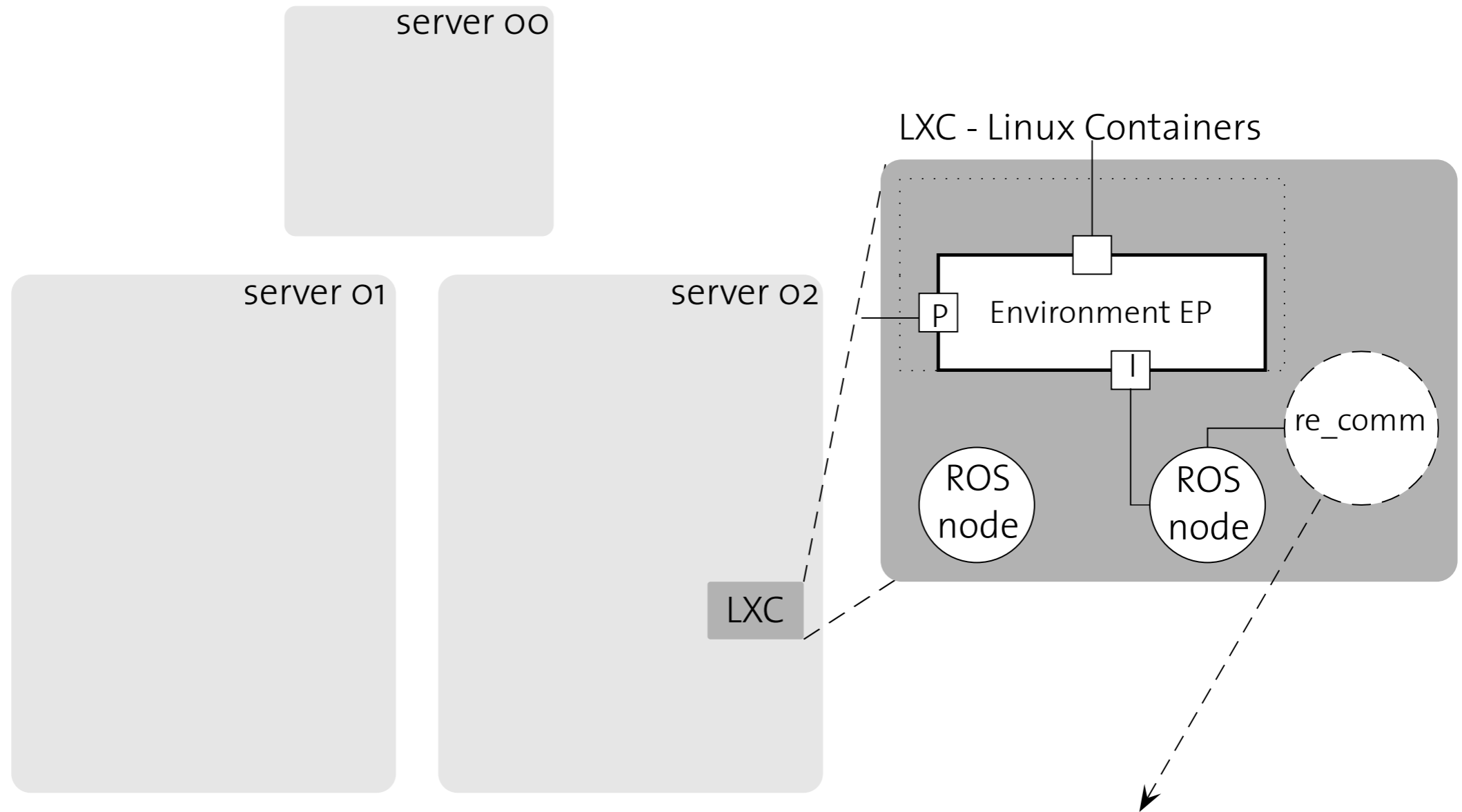
ASUS Xtion PRO (~200$)

ASUS USB-N53 (35$)

ODROID U2 (~90$)

connectivity ~90Mbps

Task: ETH Zurich office, Amazon Ireland server,
map it in real time!

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Turtlebot: Internet Edition

Real Time Visualization

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Details

server 00

LXC - Linux Containers

server 01   server 02
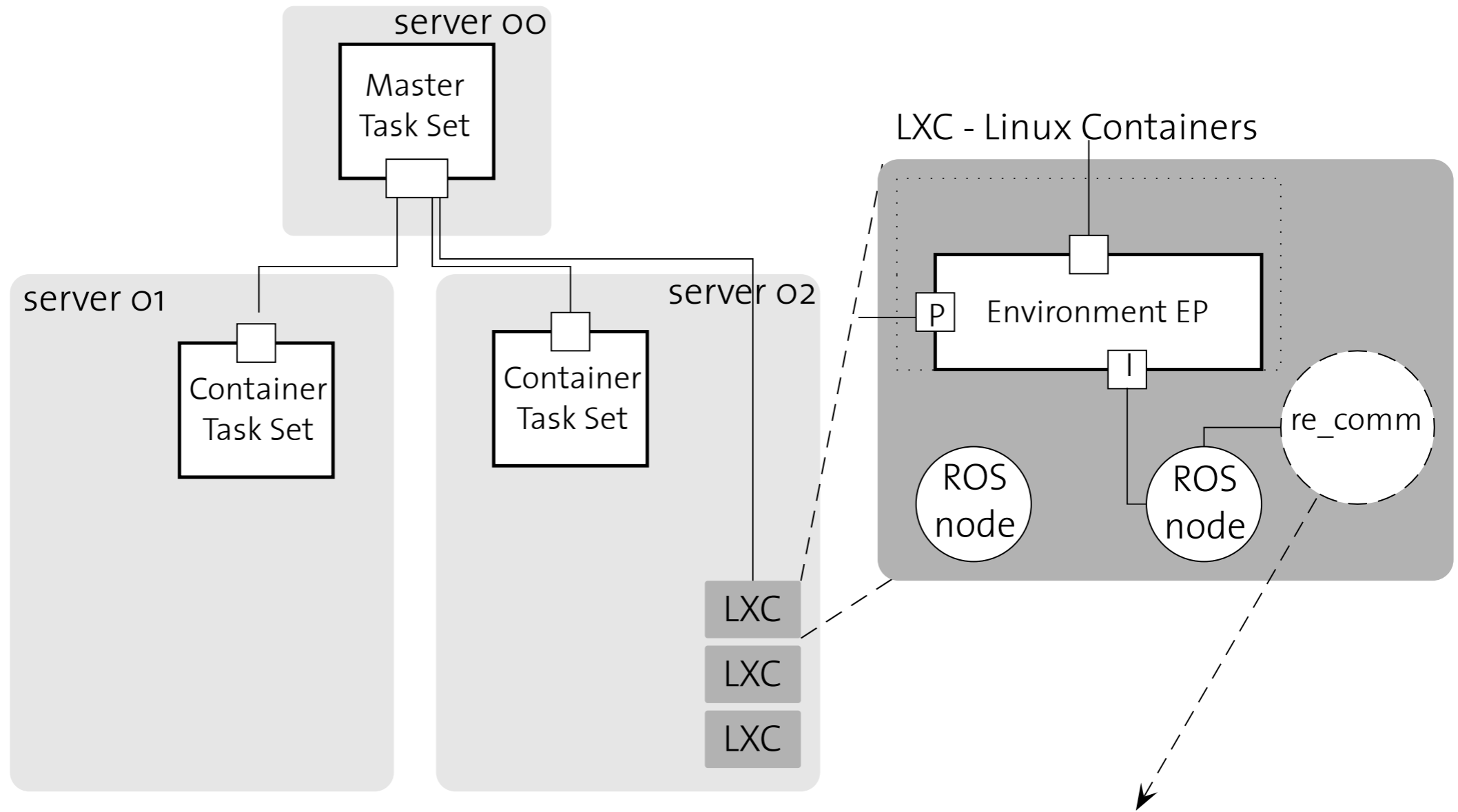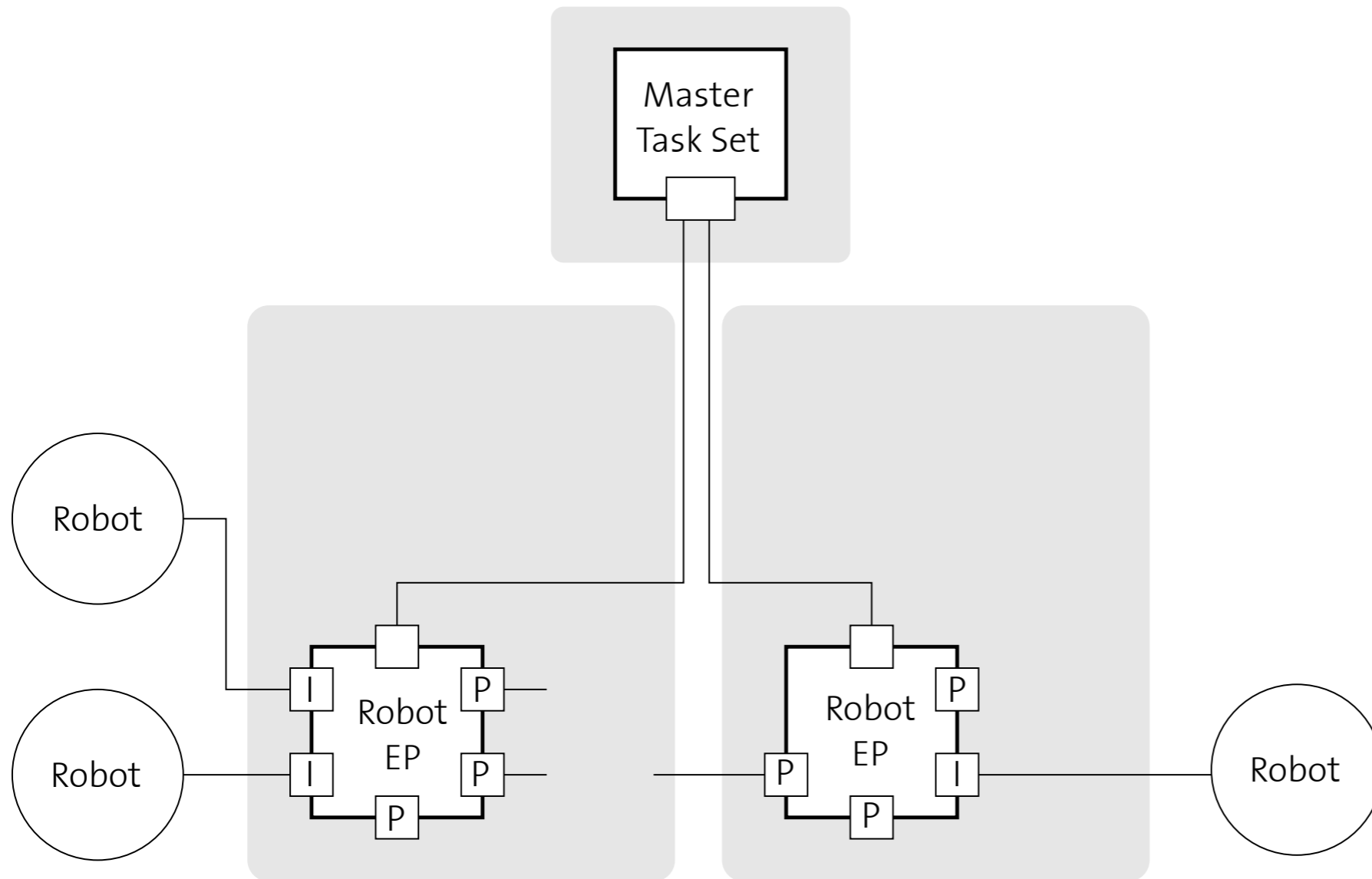
P   Environment EP

I

re_comm

ROS node   ROS node

LXC

✓ Secure, Light weight, ROS compatible computing environments with Linux Containers

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Details

server 00

Master
Task Set

server 01

server 02

Container
Task Set

Container
Task Set

LXC

LXC

LXC

LXC - Linux Containers

P   Environment EP

I

ROS
node
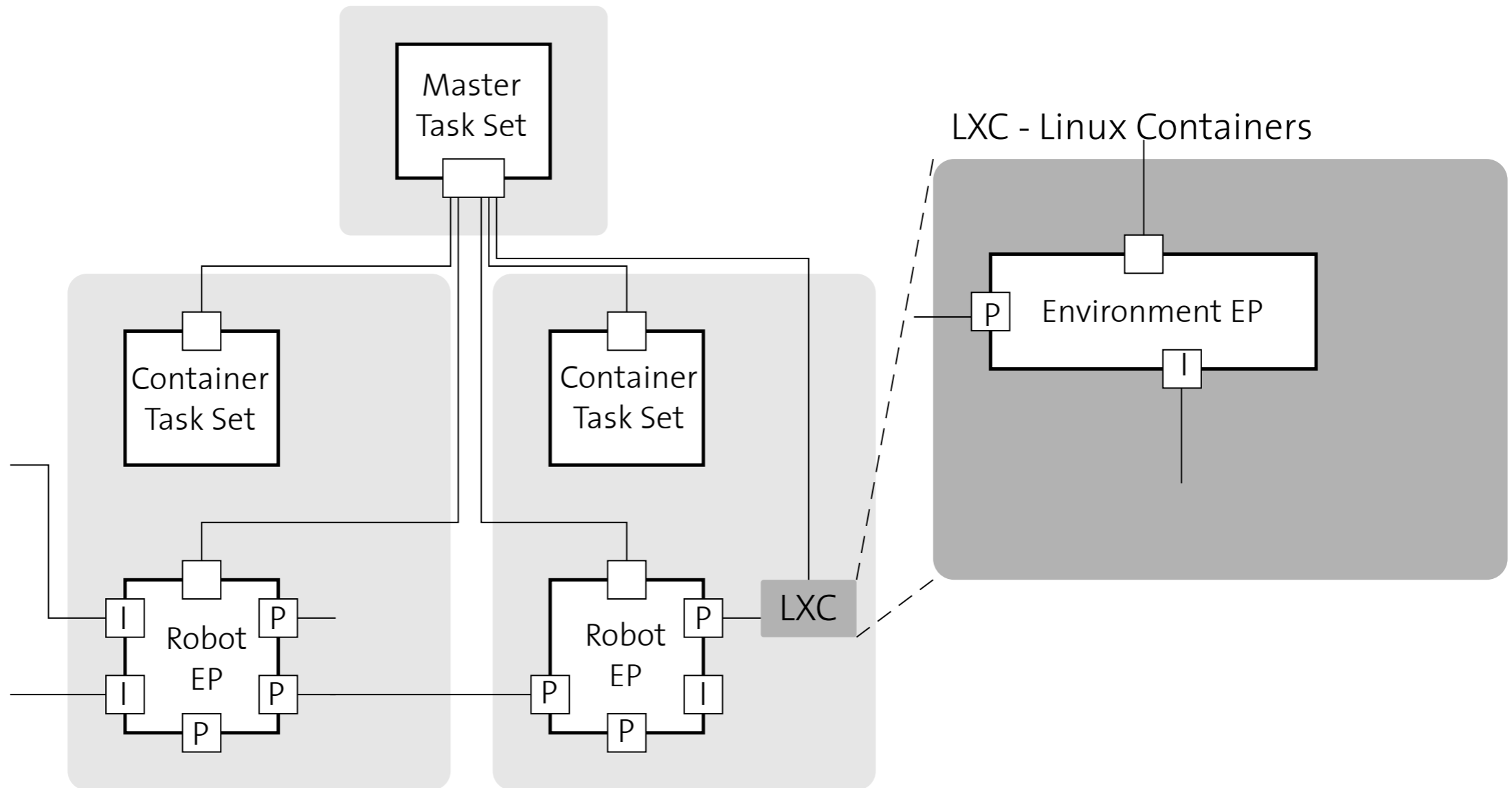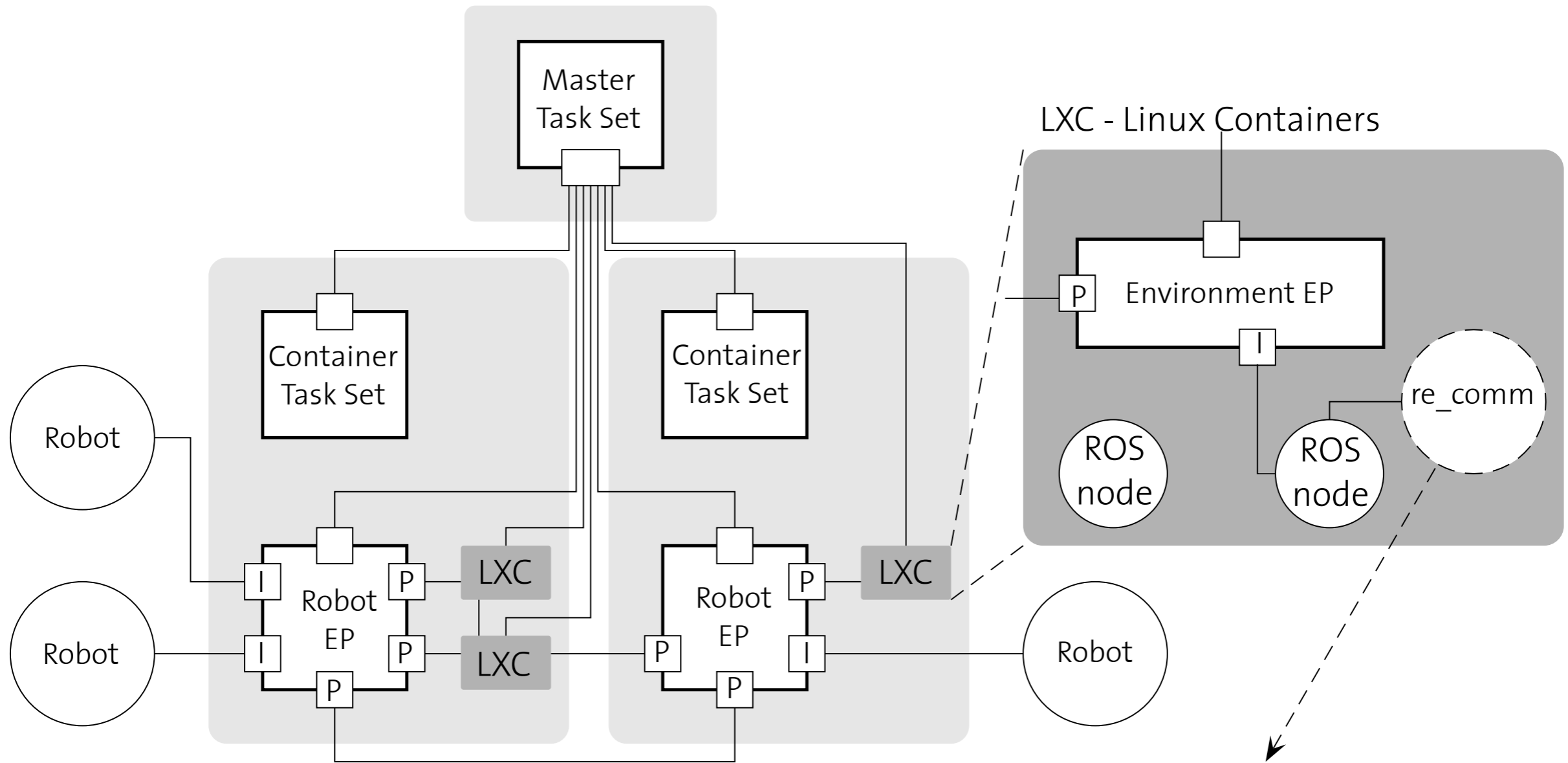
ROS
node

re_comm
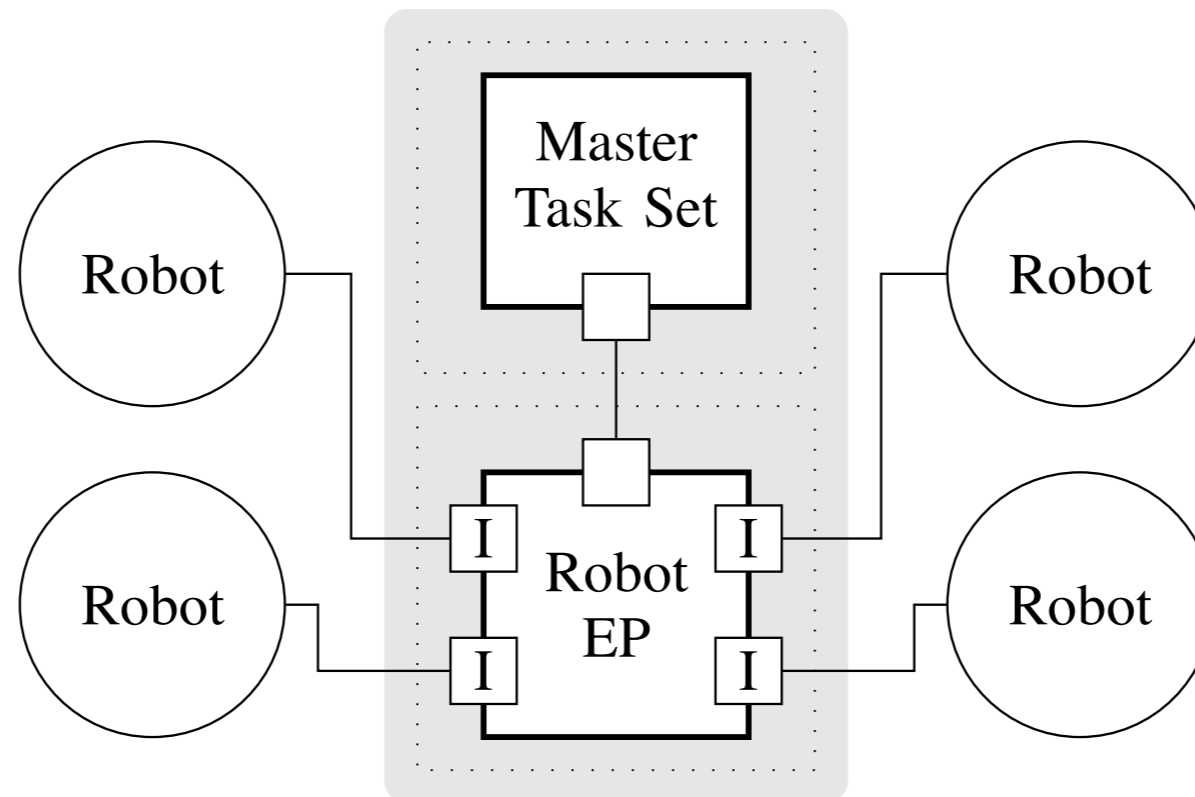
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Details

Details

Details

Other use cases

- Robot Networking

- rosbridge like functionality
- multi master functionality

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Ongoing Work - Computation

- repo-server

- private virtual network

- public instance

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Conclusion

- Discussed the core components
  - RoboEarth Language
  - RoboEarth Storage
  - RoboEarth Cloud Engine
- More details
  - http://roboearth.org/software-components

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Thank you for you attention!

- Cloud Robotics Workshop

http://www.roboearth.org/iros2013

- Looking for developers, gajan@ethz.ch