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## Automating Cataloging and Discovery of Services for Service-Oriented Robotic Systems

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# Automating Cataloging and Discovery of Services for Service-Oriented Robotic Systems

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LARS 2014, São Carlos/SP



# Agenda

Introduction

Developing RoboSeT

Case Study

Discussion


Conclusion and Future Work

# Introduction

- Robots have been used in several areas of the society
- Complexity and diversity challenge the development of robotic systems
- Service-Oriented Architecture (SOA) promotes better reusability and flexibility to robotic systems
- Several Service-Oriented Robotic Systems (SORS) can be found in the literature
- Development environments for SORS are also available

# Introduction

- Motivation:
  - SORS development environments do not provide facilities for location and selection of services

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<a href="#">LMS1xx</a>	Konrad Banachowicz	Driver for SICK LMS1xx.

# Introduction

- Motivation:
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## Which service controls

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## a laser sensor?

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# Introduction

- Motivation:
  - SORS development environments do not provide facilities for location and selection of services

Is this service the most indicated one?

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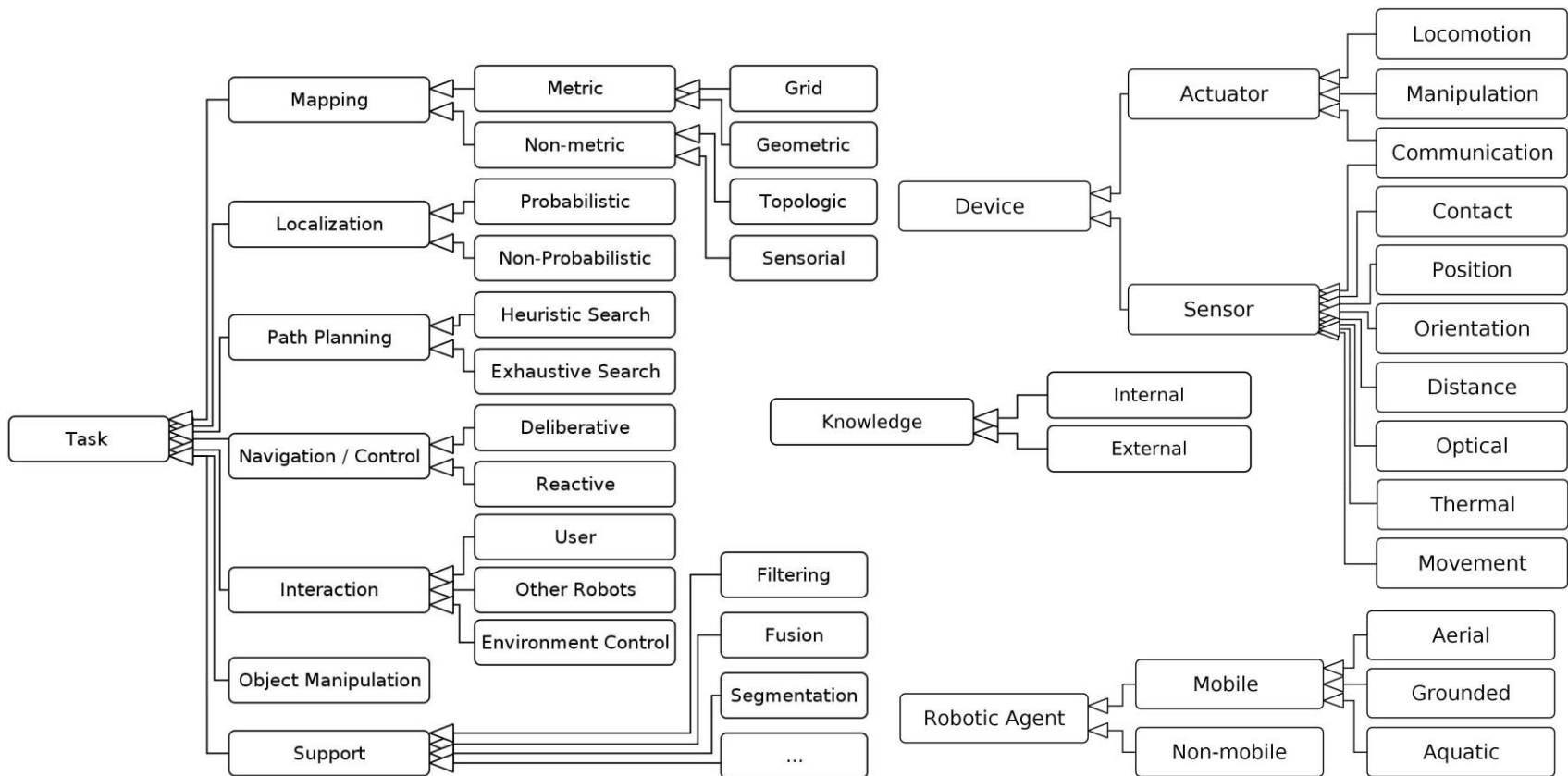
# Introduction

- Main goal:
  - To present RoboSeT (Robotics Services Semantic Search Tool), a mechanism that supports cataloging and discovery of services for robotic systems using semantic information.



# Developing RoboSeT

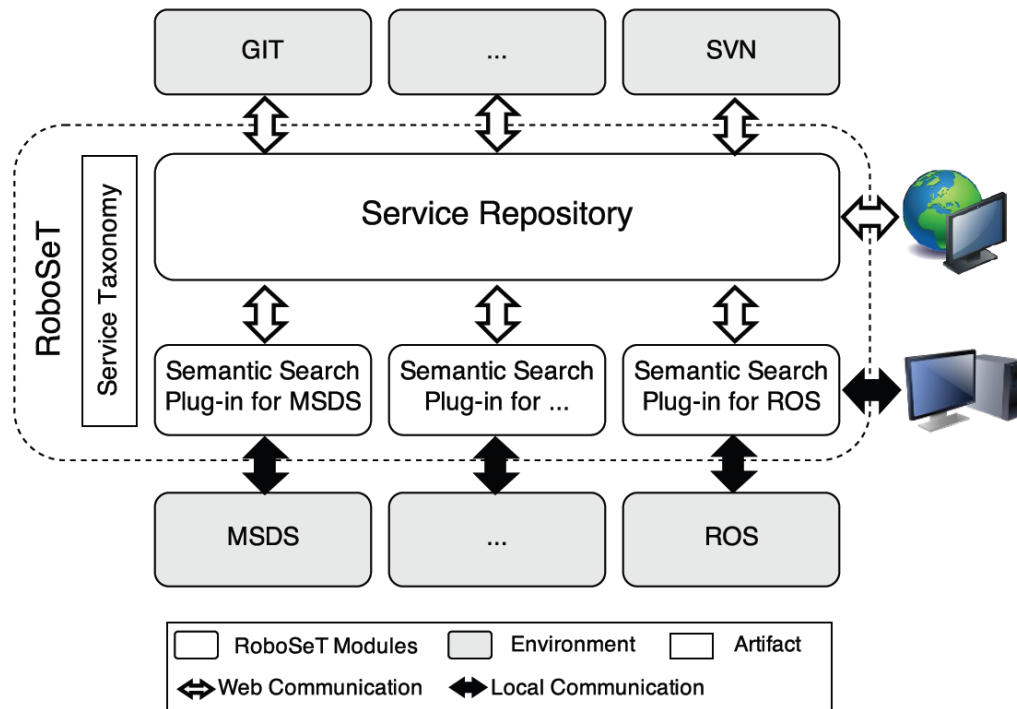
- First step: Establishment of a common vocabulary [1]



[1] Oliveira, L. B. R.; Osório, F. S.; Oquendo, F.; Nakagawa, E. Y.; Towards a Taxonomy of Services for Developing Service-Oriented Robotic Systems. In: *SEKE'14*, 2014, Vancouver, Canada, p. 344-349.

# Developing RoboSeT

- RoboSeT is divided into two main subsystems:
  - Service repository (Web Interface)
  - Service plug-ins (GUI or command line)



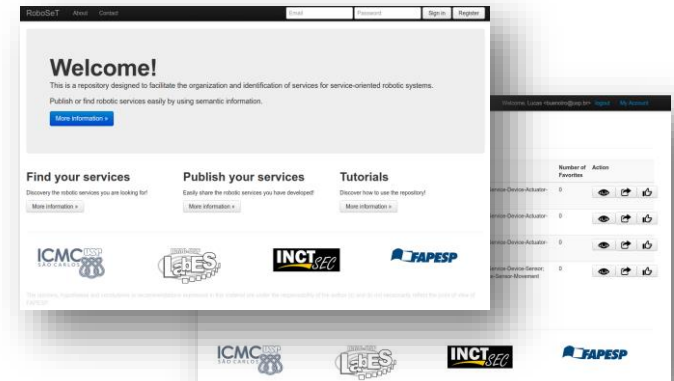
# Developing RoboSeT

- Service repository:

- Account management
- Service publication
- Service search and detailing
- Service management
- News about services

- Plug-ins:

- Service search
- Service identification
- Service obtaining and deployment
- Feedback about services (quality, bugs, comments)



```
br> view encl
>>> Service ID: 2
>>> Service Name: encl
>>> Service Endpoint: https://github.com/ros-planning/navigation
>>> Service Version: v1.0
>>> Service License: GNU GPL v3
>>> Service Description: Is a probabilistic localization system for a robot moving in 2D. It implements the ad
>>> aptive (or KLD-sampling) Monte Carlo localization approach (as described by Dieter Fox), which uses a particle
>>> filter to track the pose of a robot against a known map.
>>> Service Type: Service-Task-Localization-Probabilistic
>>> Quality Attributes:
>>> Characteristic      Subcharacteristic      Score      Reviews
>>> Functional Suitability  Appropriateness      1.5      2
>>> Functional Suitability  Accuracy      1.0      1
>>> Operability      Ease of use      1.0      1
>>>
```

# Case study

- Design of a robotic system for robust navigation
  - Motion Planning
  - Trajectory generation
  - Obstacle detection and representation
  - Obstacle avoidance
  - Position and velocity control
  - Localization
  - Laser controller
  - Pioneer P3-DX controller

# Case study

- Mapping requirements into service types

<b>Functionality</b>	<b>Service type</b>
Motion Planning	Service/Task/Path planning
Trajectory generation	Service/Task/Path planning
Obstacle detection and representation	Service/Task/Mapping
Obstacle avoidance	Service/Task/Path planning
Position and velocity control	Service/Task/Navigation
Localization	Service/Task/Localization
Encoder controller	Service/Device/Sensor/Movement
Differential drive controller	Service/Device/Actuator/Locomotion
Laser controller	Service/Device/Sensor/Distance

# Case study

- Searching for ROS services

**Service Types**

- Service-Task
- Service-Task-Interaction
- Service-Task-Interaction-Environment Control
- Service-Task-Interaction-Other Robots
- Service-Task-Interaction-User
- Service-Task-Localization**
- Service-Task-Localization-Non Probabilistic
- Service-Task-Localization-Probabilistic
- Service-Task-Mapping
- Service-Task-Mapping-Metric
- Service-Task-Manning-Metric-Geometric

Search Back View Service Type

**Robotic Services**

ID	Service	Provider	Service Types	Number of Favorites	Action
2	amcl	milena.guessi@gmail.com	Service; Service-Task; Service-Task-Localization; Service-Task-Localization-Probabilistic	1	
3	base_local_planner	amaral.felipeaugusto@gmail.com	Service; Service-Task; Service-Task-Navigation/Control; Service-Task-Navigation/Control-Reactive	0	
4	carrot_planner	amaral.felipeaugusto@gmail.com	Service; Service-Task; Service-Task-Path Planning	0	
5	clear_costmap_recovery	amaral.felipeaugusto@gmail.com	Service; Service-Task; Service-Task-Mapping	0	
6	costmap_2d	amaral.felipeaugusto@gmail.com	Service; Service-Task; Service-Task-Mapping; Service-Task-Mapping-Metric; Service-Task-Mapping-Metric-Grid	0	

# Case study

- Searching for ROS services (Part I)

Functionality	Task service type	ROS Service
Motion Planning	Path planning/Heuristic Search	NavfnROS, CarrotPlanner
Trajectory generation	Path planning/Heuristic Search	TrajectoryPlannerROS, DWAPlannerROS
Obstacle detection and representation	Mapping/Metric/Grid	CostMap2D
Obstacle avoidance	Path planning/Heuristic Search	TrajectoryPlannerROS, DWAPlannerROS
Position and velocity control	Navigation	MoveBase
Localization	Localization/Probabilistic	Amcl

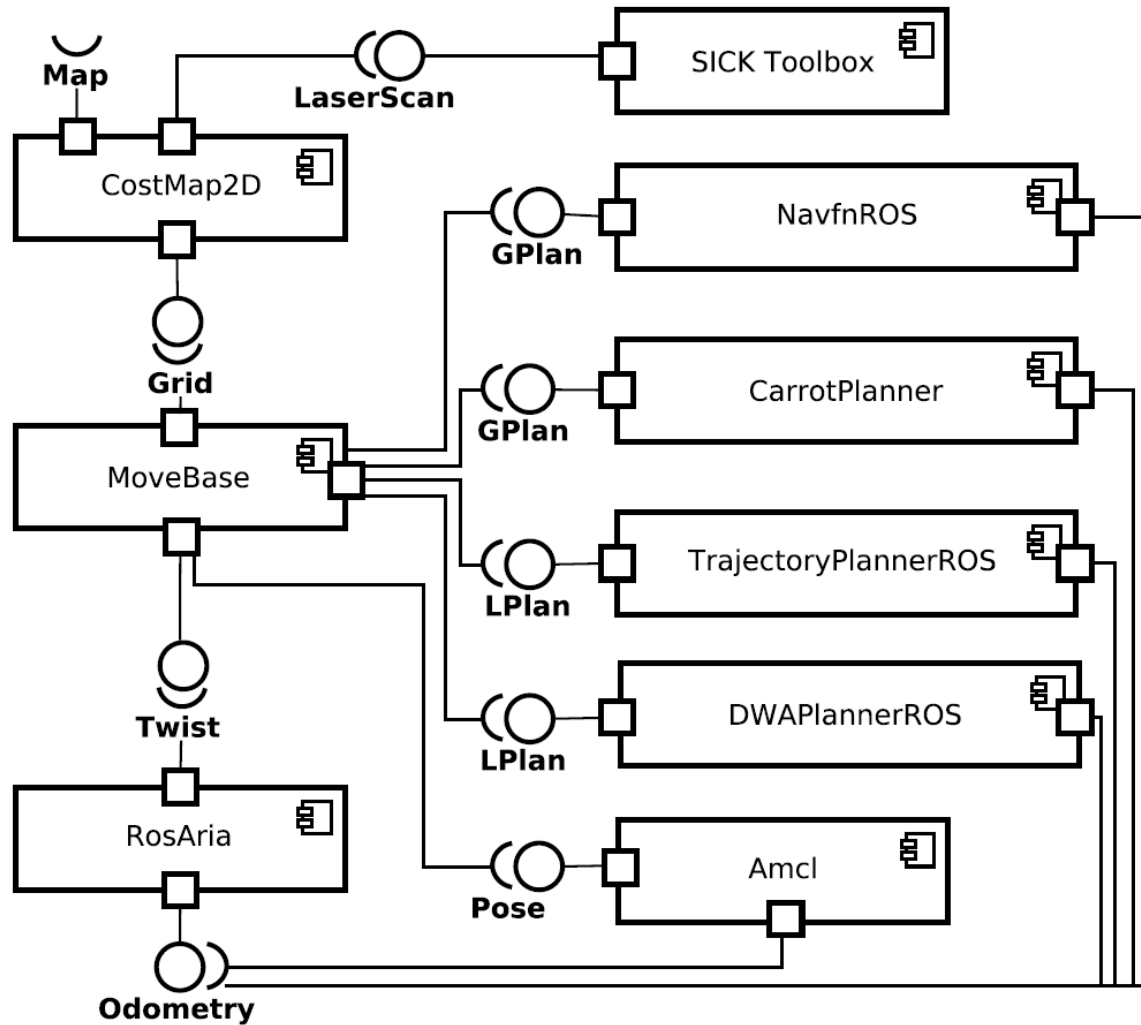
# Case study

- Searching for ROS services (Part II)

<b>Functionality</b>	<b>Device service type</b>	<b>ROS Service</b>
Encoder controller	Sensor/Movement	RosAria
Differential drive controller	Actuator/Locomotion	RosAria
Laser controller	Sensor/Distance	SICK Toolbox



# Case study



# Discussion

- Advantages:
  - Services can be transparently shared and discovered
  - Services that are easier to be found are more likely to be reused
  - Structured information can support identification of more suitable services
  - Reuse improvements positively influence productivity in software systems development
  - Community feedback can guide the development of services of better quality

# Discussion

- Main limitation:
  - RoboSeT is depended on community adoption and cooperation
- Current initiatives to mitigate such limitation:
  - To promote RoboSeT in the robotics community
  - To release an open source version of RoboSeT

# Conclusion and Future Work

- SOA is a promising architectural style for robotics
- A mechanism for supporting cataloging, publishing, and discovery of services can contribute to the SORS development
- Results indicate that RoboSeT can ease the discovery of services for SORS
- Future work:
  - To perform an experiment
  - To develop new functionalities and plug-ins

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