CSC752 Autonomous Robotic Systems
- Introduction into ROS (4) -

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OVERVIEW

- ROS services
- ROS actions (actionlib)
- ROS time
- ROS bags
- Debugging strategies
- Request/response communication between nodes is realized with services
  - The *service server* advertises the service
  - The *service client* accesses this service
- Similar in structure to messages, services are defined in *.srv* files

List services:
```
~$ rosservice list
```

Show service type:
```
~$ rosservice type /service_name
```

Call service requesting content:
```
~$ rosservice call /service_name args
```

Details at: [http://wiki.ros.org/Services](http://wiki.ros.org/Services)
ROS SERVICE EXAMPLE

**std_srvs/Trigger.srv**

```c
--
bool success  # indicate successful run of triggered service
string message # informational, e.g. for error messages
```

**nav_msgs/GetPlan.srv**

```c
# Get a plan from the current position to the goal Pose
# The start pose for the plan
geometry_msgs/PoseStamped start

# The final pose of the goal position
geometry_msgs/PoseStamped goal

# If the goal is obstructed, how many meters the planner can
# relax the constraint in x and y before failing.
float32 tolerance

--
nav_msgs/Path plan
```
ROS SERVICE EXAMPLE

T1: run roscore

~$roscore

T2: run a ros service

~$rosrun roscpp_tutorials add_two_ints_server

T3: list services

~$rosservice list

T3: call service

~$rosservice call /add_two_ints 25 12
Create a service server:

```cpp
ros::ServiceServer service = nodeHandle.advertiseService(service_name, callback_function);
```

When a service request is received, the callback function is called with the request as argument.

Fill in the response to the response argument.

Return to function with true to indicate that it has been executed properly.

Details at: http://wiki.ros.org/roscpp/Overview/Services
Create a service client:

```cpp
ros::ServiceClient client = nodeHandle.serviceClient<service_type>(service_name);
```

Create service request contents

```cpp
service.request
```

Call service with

```cpp
client.call(service)
```

Response in

```cpp
service.response
```

Details at: [http://wiki.ros.org/roscpp/Overview/Services](http://wiki.ros.org/roscpp/Overview/Services)
- Similar to service calls, but provide possibility to
  - Cancel the task (preempt)
  - Receive feedback on the progress
- Best way to implement interfaces to time-extended, goal-oriented behaviors
- Similar in structure to services, action are defined in *.action files
- Internally, actions are implemented with a set of topics

Details at:
http://wiki.ros.org/actionlib
http://wiki.ros.org/actionlib/DetailedDescription
Averaging.action

#goal definition
int32 samples
---

#result definition
float32 mean
float32 std_dev
---

#feedback
int32 sample
float32 data
float32 mean
float32 std_dev

FollowPath.action

Goal

navigation_msgs/Path path
---

Result

bool success
---

Feedback

float32 remaining_distance
float32 initial_distance
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<th>Description</th>
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<th>Dynamic reconfiguration</th>
<th>Topics</th>
<th>Services</th>
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<table>
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<th>One-way continuous data flow</th>
<th>Short triggers or calculations</th>
<th>Task execution and robot actions</th>
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| Examples | Topic names, camera settings, calibration data, robot setup | Controller parameters | Sensor data, robot state | Trigger change, request state, compute quantity | Navigation, grasping, motion execution |
ROS TIME

- ROS uses the PC’s system clock as time source (wall time)
- For simulations or playback of logged data, it is convenient to work with a simulated time (pause, slow-down etc.)
- To work with a simulated clock:
  - Set the `/use_sim_time` parameter
    ```bash
    ~$rosparam set use_sim_time true
    ```
  - Publish the time on the topic `/clock` from
    - Gazebo (enabled by default)
    - ROS bag (use option `--clock`)
- To take advantage of the simulated time, you should always use the ROS Time APIs:
  - `ros::Time`
    ```cpp
    ros::Time begin = ros::Time::now();
    double secs = begin.toSec();
    ```
  - `ros::Duration`
    ```cpp
    ros::Duration duration(0.5); // 0.5s
    ```
  - `ros::Rate`
    ```cpp
    ros::Rate rate(10); // 10Hz
    ```
- If wall time is required, use `ros::WallTime`, `ros::WallDuration`, and `ros::WallRate`

Details at:
- [http://wiki.ros.org/Clock](http://wiki.ros.org/Clock)
- [http://wiki.ros.org/roscpp/Overview/Time](http://wiki.ros.org/roscpp/Overview/Time)
A bag is a format for storing message data

- Binary format with file extension *.bag
- Suited for logging and recording datasets for later visualization and analysis

**Record topics in a bag**
```
~$rosbag record --all
```

**Record specific topics**
```
~$rosbag record topic_1 topic_2 topic_3
```

Stop recording with Ctrl + C

Bags are saved with start date and time as file name in the current folder (e.g. 2020-09-17-12-58-14.bag)

**Show information about a bag**
```
~$rosbag info bag_name.bag
```

**Read a bag and play/publish its contents**
```
~$rosbag play bag_name.bag
```

Including playback options, e.g.
```
~$rosbag play --rate=0.5 bag_name.bag
```

- **--rate=factor** Publish rate factor
- **--clock** Publish clock time (set param use_sim_time to true)
- **--loop** Look playback

**Details at:**
- [http://wiki.ros.org/Clock](http://wiki.ros.org/Clock)
- [http://wiki.ros.org/roscpp/Overview/Time](http://wiki.ros.org/roscpp/Overview/Time)
› Compile and run code often to catch bugs early
› Understand compilation and runtime error messages
› Use analysis tools to check data flow (rosnode info, rostopic echo, roswtf, rqt_graph etc.)
› Visualize and plot data (RViz, RQT Multiplot etc.)
› Divide program into smaller steps and check intermediate results (ROS_INFO, ROS_DEBUG etc.)
› Make your code robust with argument and return value checks and catch exceptions
› If things don’t make sense, clean your workspace

› Use breakpoints if you use an IDE
› Maintain code with unit tests and integration tests

Build with DEBUG mode and use GDB and/or Valgrind

~$catkin config --cmake-args -DCMAKE_BUILD_TYPE=Debug

Details at:
ROS UnitTests
http://wiki.ros.org/gtest
http://wiki.ros.org/rostest
http://wiki.ros.org/roslaunch/Tutorials/
Roslaunch%20Nodes%20in%20Valgrind%20or%20GDB

~$catkin_make clean --all
FURTHER REFERENCES

- ROS Wiki
  - http://wiki.ros.org/
- Installation
  - http://wiki.ros.org/ROS/Installation
- Tutorials
  - http://wiki.ros.org/ROS/Tutorials
- Packages
  - https://www.ros.org/browse/list.php

- ROS Cheat Sheet
  - https://kapeli.com/cheat_sheets/ROS.docset/Contents/Resources/Documents/index
- ROS Best Practices
  - https://github.com/leggedrobotics/ros_best_practices/wiki
- ROS Package Templates
  - https://github.com/leggedrobotics/ros_best_practices/tree/master/ros_package_template
Material is based on ROS Wiki and ETH Zürich ROS Introduction (https://rsl.ethz.ch/)