Actions and Plans

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Summary

- **ROS Actionlib**
  how to write actions in ROS
- **Petri Net Plans**
  how to write complex plans
- **PNPros**
  ROS bridge for PNP
- **Examples**
  Execution of complex plans ROS Actions + PNP

More info, source code, etc. in
http://www.dis.uniroma1.it/~iocchi/Teaching/rp/PNPROS/

ROS actionlib

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What is actionlib

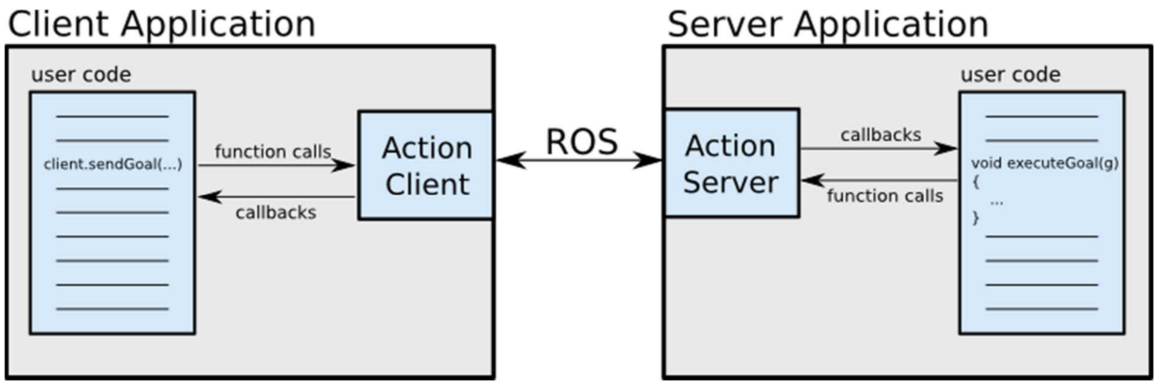
- Node A sends a request to node B to perform some task
- Services are suitable if task is "instantaneous"
- Actions are more adequate when task takes time and we want to monitor, have continuous feedback and possibly cancel the request during execution

What is actionlib

- actionlib package provides tools to
  - create servers that execute long-running tasks (that can be preempted).
  - create clients that interact with servers

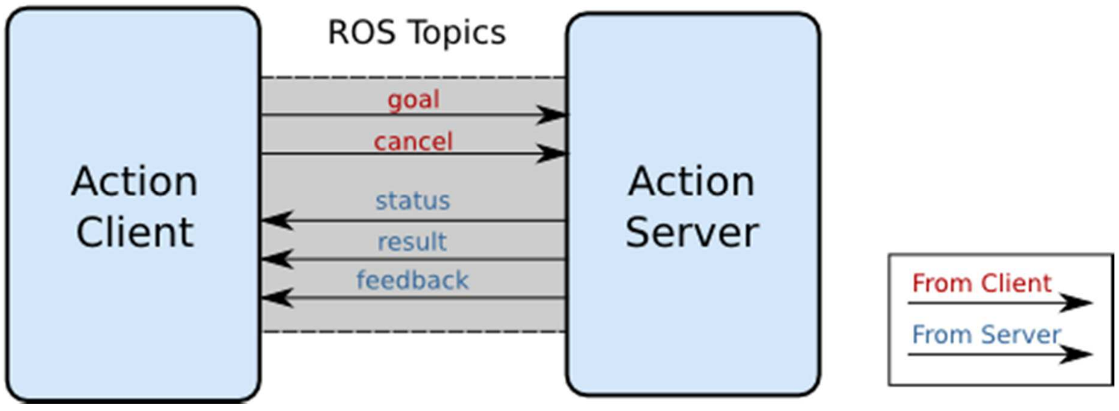
References
- http://wiki.ros.org/actionlib
- http://wiki.ros.org/actionlib/DetailedDescription
- http://wiki.ros.org/actionlib/Tutorials

What is actionlib

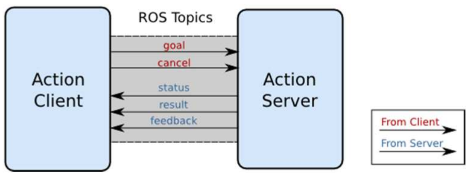


Client-server interaction using
"ROS Action Protocol"

Client-Server Interaction



Client-Server Interaction

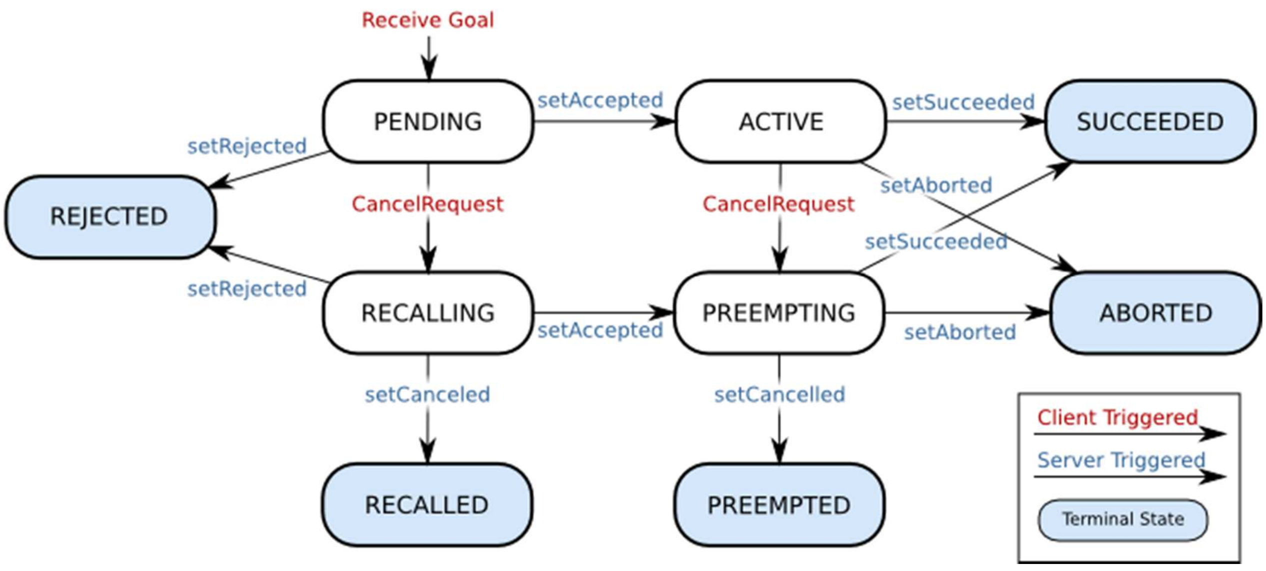


- **goal** - Used to send new goals to server
- **cancel** - Used to send cancel requests to server
- **status** - Used to notify clients on the current state of every goal in the system.
- **feedback** - Used to send clients periodic auxiliary information for a goal
- **result** - Used to send clients one-time auxiliary information upon completion of a goal

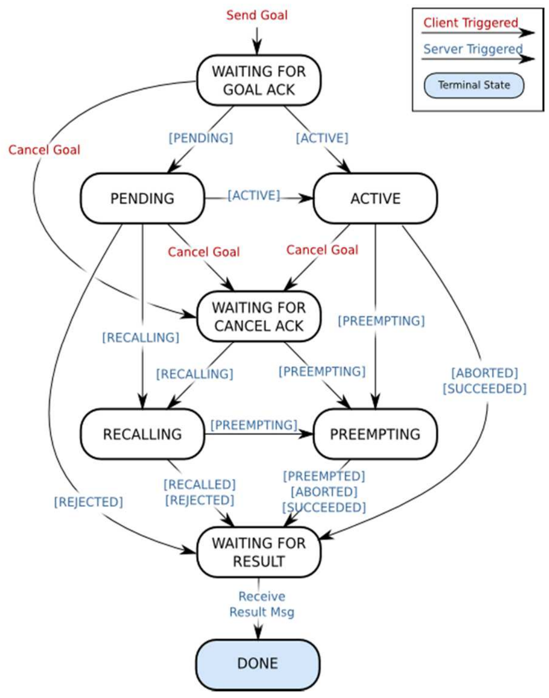
Actions and Goal ID

- Action templates are defined by a name and some additional properties through an .action structure defined in ROS
- Each instance of an action has a unique Goal ID
- Goal ID provides the action server and the action client with a robust way to monitor the execution of a particular instance of an action.

Server State Machine

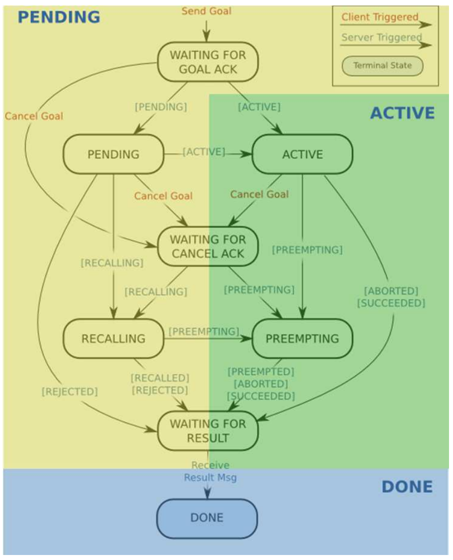


Client State Machine



SimpleActionServer/Client

- SimpleActionServer: implements a single goal policy.
- Only one goal can have an active status at a time.
- New goals preempt previous goals based on the stamp in their GoalID field.
- SimpleActionClient: implements a simplified ActionClient



Example: move_base action server

- **Action Subscribed Topics**
  - move_base/goal (move_base_msgs/MoveBaseActionGoal): A goal for move_base to pursue in the world.
  - move_base/cancel (actionlib_msgs/GoalID): A request to cancel a specific goal.
- **Action Published Topics**
  - move_base/feedback (move_base_msgs/MoveBaseActionFeedback): Feedback contains the current position of the base in the world.
  - move_base/status (actionlib_msgs/GoalStatusArray): Provides status information on the goals that are sent to the move_base action.
  - move_base/result (move_base_msgs/MoveBaseActionResult): Result is empty for the move_base action.

Sending a goal with move_base

```
typedef actionlib::SimpleActionClient<move_base_msgs::MoveBaseAction>
MoveBaseClient;
//tell the action client that we want to spin a thread by default
MoveBaseClient ac("move_base", true);
//wait for the action server to come up
while(!ac.waitForServer(ros::Duration(5.0))){
   ROS_INFO("Waiting for the move_base action server to come up");
}
 // setting the goal
move_base_msgs::MoveBaseGoal goal;
goal.target_pose.header.frame_id = "base_link";
goal.target_pose.header.stamp = ros::Time::now();
goal.target_pose.pose.position.x = 1.0;
goal.target_pose.pose.orientation.w = 1.0;
```

Sending a goal with move_base

```
// sending the goal
ac.sendGoal(goal);

// wait until finish
while (!ac.waitForResult(ros::Duration(1.0)))
   ROS_INFO("Running...");

// print result
if(ac.getState() == actionlib::SimpleClientGoalState::SUCCEEDED)
   ROS_INFO("Hooray, the base moved 1 meter forward");
else
   ROS_INFO("The base failed to move forward 1 meter for some reason");
```

Cancelling a goal with move_base

```
typedef actionlib::SimpleActionClient<move_base_msgs::MoveBaseAction>
MoveBaseClient;

MoveBaseClient ac("move_base", true);
…

// Cancel all active goals
ac.cancelAllGoals();
```

Example with move_base

rp_action package - download from github (see next slides)

```
PNPros/example/rp_action/scripts$ ./run-dis-B1.sh
$ rosrun rp_action gotopose robot_0 10 2 0
$ rosrun rp_action stopmove robot_0
```

Defining actions

Define an action file (e.g., Turn.action in rp_action/action folder)

#Goal

- specification of the goal

#Result

- specification of the result

#Feedback

- specification of the feedback

```
# Goal
# target_angle [DEG]
float32 target_angle
# flag ABS/REL
string absolute_relative_flag
# max angular velocity [DEG/s]
float32 max_ang_vel
---
# Result
string result
---
# Feedback
string feedback
```

Building actions

Catkin

Add the following to your CMakeLists.txt file before catkin_package().

```
find_package(catkin REQUIRED genmsg actionlib_msgs actionlib)
add_action_files(DIRECTORY action FILES DoDishes.action)
generate_messages(DEPENDENCIES actionlib_msgs)
```

Additionally, the package's package.xml must include the following dependencies:

```
<build_depend>actionlib</build_depend>
<build_depend>actionlib_msgs</build_depend>
<run_depend>actionlib</run_depend>
<run_depend>actionlib_msgs</run_depend>
```

Building actions

Rosbuild

Add the following to your CMakeLists.txt before rosbuild_init().

```
rosbuild_find_ros_package(actionlib_msgs)
include(${actionlib_msgs_PACKAGE_PATH}/cmake/actionbuild.cmake)
genaction()
```

Then, after the output paths, uncomment (or add)

```
rosbuild_genmsg()
```

Additionally, the package's manifest.xml must include the following dependencies:

```
<depend package="actionlib"/>
<depend package="actionlib_msgs"/>
```

Writing an action server

```
class TurnActionServer {
protected:
   ros::NodeHandle nh;
   std::string action_name;
   actionlib::SimpleActionServer<rp_actions::TurnAction> turn_server;
public:
   TurnActionServer(std::string name) :       action_name(name),
      turn_server(nh, action_name,
                                       boost::bind(&TurnActionServer::executeCB, this, _1), false)
   {  turn_server.start();  }

   void executeCB(const rp_actions::TurnGoalConstPtr& goal)  {
      …
   }
}
```

Writing an action client

```
std::string action_name = "turn";
// Define the action client (true: we want to spin a thread)
actionlib::SimpleActionClient<rp_actions::TurnAction> ac(action_name , true);
// Wait for the action server to come up
while(!ac.waitForServer(ros::Duration(5.0))) {
    ROS_INFO("Waiting for turn action server to come up");
}
// Set the goal
rp_actions::TurnGoal goal;
goal.target_angle = 90;  // target deg
goal.absolute_relative_flag = "REL"; // relative
goal.max_ang_vel = 45.0;  // deg/s
// Send the goal
ac.sendGoal(goal);
```

Example with Turn action

rp_actions package

```
scripts$ ./run-dis-B1.sh
bin$ ./
```

```
PNPros/example/rp_action/scripts$ ./run-dis-B1.sh
$ rosrun rp_action turn -client robot_0 90  REL
```

ActionServer/Client

- **ActionServer** and **ActionClient** use the complete set of states and transitions.
- More difficult to program.
- Needed when we want to execute multiple instances of an action at the same time (parallel actions).
- Implemented in PNPros module.

Conclusions

- **ActionLib** powerful library to write and control duration processes/actions
- SimpleActionServer/Client easy to use, standard ActionServer/Client more difficult, but not typically needed
- ActionLib is integrated other libraries for action combination:
  - SMACH: hyerarchical state machines
  http://wiki.ros.org/smach
  - **PNP: Petri Net Plans**
  http://pnp.dis.uniroma1.it

Exercise

Write an action for time countdown.

Write a SimpleActionServer that counts down for *n* seconds, displaying on the screen the count down at each second.

Write a SimpleActionClient that activates a count down specifying the amount of seconds

Write a SimpleActionClient that stops the count down

Note: with SimpleActionServer/Client it is not possible to run two counters at the same time