Using Multiple Masters to Preserve Robot Independence and Reduce Network Latency in a ROS System

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Introduction

ROS (Robot Operating System) is a system of libraries and tools that helps developers make robot applications.

It provides:

- package management
- hardware abstraction
- libraries
- visualizers
- message passing
- other useful robot development tools

An active ROS system consists of a set of **nodes**.

A **Master** node provides:

- naming and registration services (for nodes to find each other)
- a Parameter Server (that nodes use as a shared dictionary)

Nodes communicate by:

- publishing / subscribing to **topics**
- offering / requesting **services**

References

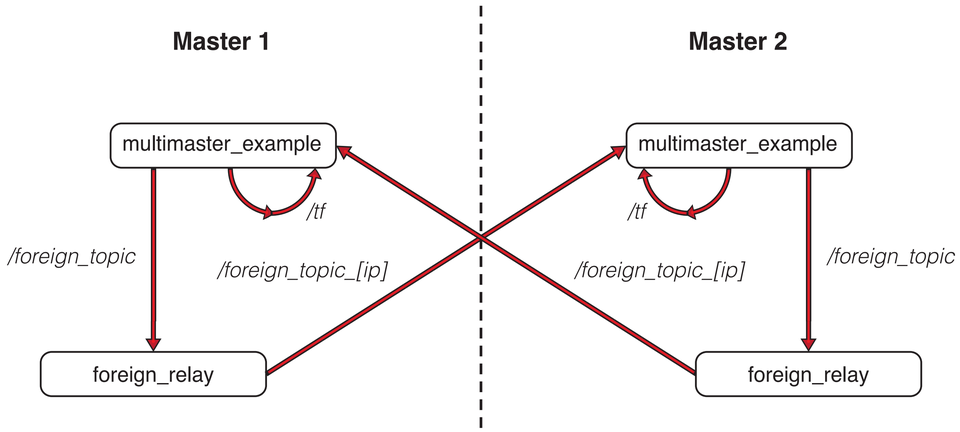
- **http://www.ros.org/wiki/wifi_comm**

Problem: Single Master

Many robotic systems require wireless communication between multiple robots. The only quick way to do this in ROS is to run a single Master on one of the robots, which all of the robots use to initialize nodes and access parameters. This presents two main problems:

- Robots disconnected from Master cannot initalize new nodes or wait for services => unable to plan path back to Master
- Robots want to communicate simple, high-level info, such as relative position. But in ROS:
  - *all* position info published as transforms on topic **/tf**
  - subscribers to /tf get flooded with unnecessary info, such as other robots' joint angles
  - sharing high-bandwidth topics like /tf saturates network

Implementation: Foreign Relay



Using a ROS package called **WiFi_Com`m**, we open up foreign relays between Masters.

- High-bandwidth, built-in topics like /tf can remain local
- Low-bandwidth messages can be published on /foreign_topic, which gets relayed to the other Master via foreign_relay
- If Masters become disconnected, foreign topics die, but robots remain functional
- Allows robots to communicate relative positions without saturating network

Solution: Multimaster

Giving every robot its own Master solves both problems:

- Robots retain complete independence (can initialize new nodes and wait for services even when disconnected):

  Robots can change tasks, retrieve data and take corrective action (plan a path back to wireless range).

- High-bandwidth, built-in topics like /tf remain local. Messages can be published on low-bandwidth remote (non-local) topics:

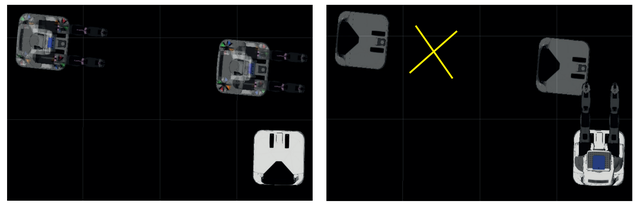
  Robots can share select data (such as its position relative to another robot) without saturating the network.

Results & Future Work

Successfully ran two-master PR2 simulations using **Gazebo** and **RViz**:

- Ran two complete PR2 simulations on two different computers, each with its own Master
- Restarting foreign relay after wireless disconnect / reconnect resumed simulation with updated robot positions
- Computed relative robot positions in real time with negligible latency (yellow X marks position of PR2 for single-master system at same time):

Local translation **Foreign translation**



Future work:

- Test with more than two robots
- Test with real robotic systems
- Rigorous testing of communication limits and points of unreliability
- Explore alternative approaches to multimaster

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