CS1951R: Introduction to Robotics
Professor Stefanie Tellex

Build, Program, and Fly your very own Drone
Battery Safety

- Don’t leave charging unattended.
- Don’t use if less than 11.3 volts.
- Don’t use if they get too hot.
Design Scenario

- You want to connect to the drone with your base station.

- Our solution
  - The Pi acts as an 802.11 Master node and advertises a public but password protected network.
  - The Pi runs a DHCP server and allocates IP addresses to anyone who connects to the network.
  - The base station connects to the Pi’s wireless network and uses TCP/IP to communicate.

- Wins:
  - Can start the Pi and connect and don’t need to talk to CIS.
  - Works anywhere!

- Cons:
  - Pi does not have an internet uplink. No “git pull”!
  - Possible network interference.
  - Need to change Wifi settings when setting up a new Pi so there is no name collision.
Design Scenario

- You want to connect to the drone with your base station.
- Our solution (2)
  - The drone connects to RLAB. So does your base station.
  - CIS maintains the RLAB access points and DHCP and DNS.
  - Both machines use the RLAB AP to talk to each other and to the internet.
- Wins:
  - Both machines have internet!
- Cons:
  - Not enough IP addresses?
  - Possible network interference.
  - Only works where there is RLAB.
So this is a peculiarity to RLAB because it assigns a FQDN to each IP but I think between Ian's class and Stefanie's class we've filled up the entire 256 subnet address space in RLAB's dhcp table? A student couldn't connect to RLAB and I was looking at nmap to find them and every IP was filled with a domain name.

Is it possible if we have had more than 256 hosts in the SciLi recently RLAB won't register new fully qualified domain names?

Advice sought on wether this could actually be a thing before I submit a trouble ticket.
Design Scenario

- You want to set up a network in your house and enable your cell phone, laptop, and desktop to connect to it.

- My solution
  - Pay Comcast for one IP address and a cable modem.
  - Purchase a WIFI Router.
  - Connect router “uplink” to cable modem.
  - Connect router LAN to desktop.
  - Connect router WIFI link to cell phone and laptop.
  - Router will run DHCP server to allocate IP addresses on LAN.

- Wins:
  - I only pay for one IP address.
  - All “my” machines are behind the NAT and can’t be hacked without first hacking the router.

- Cons:
  - I can’t be a server. Had to do gymnastics to play Minecraft with my brother-in-law.
Open Questions

- The drone has a DHCP server but no Dynamic DNS set up. How do you set up dynamic DNS on the drone so you can ping by hostname as well as by IP address?
- What is the best way for 25 drones and base stations to run at the same time?
- What is the best way to give the drone internet access when running in AP mode?
Robots to the Rescue MDS video
MDS Message Passing Libraries

- Libbot/LCM
- ROS
- YARP (Yet Another Robot Platform)
- Personal Robotics Message Passing
Robotic Software

- What programs do we need?
- How should we organize them on the file system?
- How should they talk to each other?
Software Engineering for Robotics

- Lots of different processes talk to each other.
- Processes live on different computers.
- Development trees live in different source control repository.
- Dependency management!
Cooking video
roscore

- ROS Master runs an XML RPC server to talk to *nodes* on port 11311.
- Each ROS node is a program that does something.
- Nodes publish and subscribe on *topics*.
- Environment variables
  - ROS_MASTER_URI
  - ROS_IP and/or ROS_HOSTNAME
Ros set up

- How do nodes talk to each other?

Node 1

rosmaster

Node 2
ROS Packages

- Dependencies between other packages?
  - PYTHONPATH
  - LD_LIBRARY_PATH

- Build tools.
  - CMake and Catkin
ROS

- ROS is many things
  - Standard for message passing and RPC calls
  - Standard for organizing large repositories of code for different purposes. (Compiling, running, dependency management.)
  - Implementations of useful robotic libraries.
    - TF (Transform library)
    - Rviz (Visualization)
    - rosjs (Javascript/web page integration)
    - Many more!
Design Scenario

- Robot wants to send IR stream.

- state_controller.py – receives camera, IR, IMU and sends control commands

- How should state_controller.py get IR input?
  - Function call?
  - Message passing?
Transform Library
RViz
ROSBridge and rosjs
ROS

- ROS advantages
  - It is the current standard. Everyone uses it.
  - It provides a mechanism for most common robotics problems.

- ROS disadvantages
  - Very (overly) complicated.
  - Dependencies are still hard (but easier than before ROS).
  - Some poor design decisions related to message passing, etc.