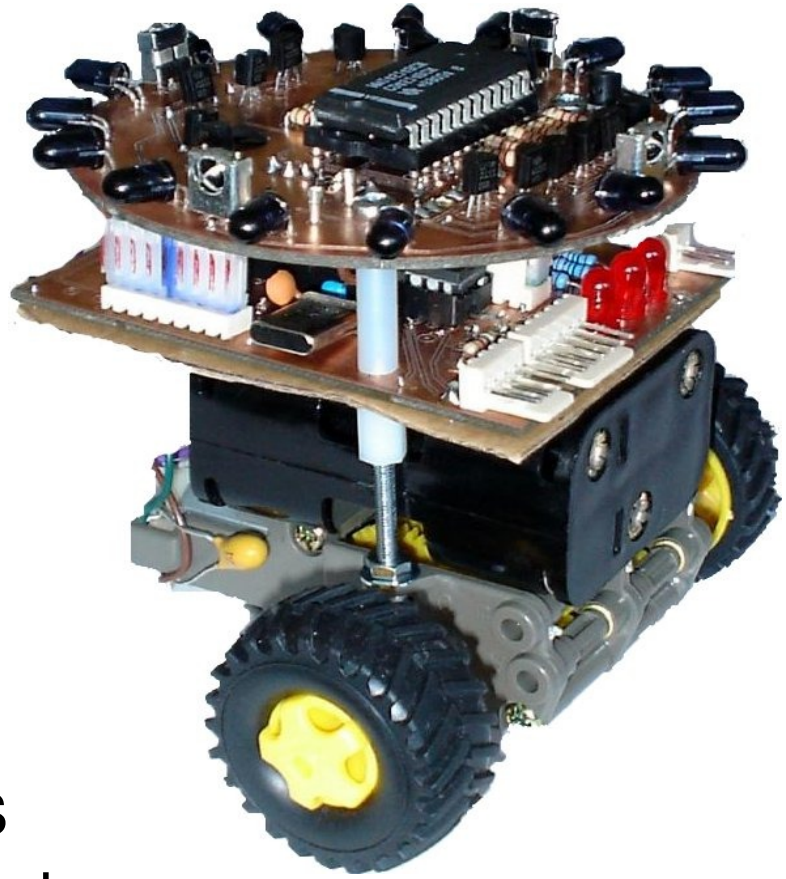
In House Ad Hoc Networks

Joseph Violi

Supervisors
Ahmet Sekercioglu
Andrew Price

Project Aims

- Creating and testing algorithms in mobile ad hoc networks
  - Localization
  - Self organization
  - Connectivity maintenance
  - Power efficiency



- Hardware
  - Atmel AVR
  - Infrared – limited to ~3Meters
    - → Testing in an indoor environment

Mobile Ad Hoc Mesh Networks

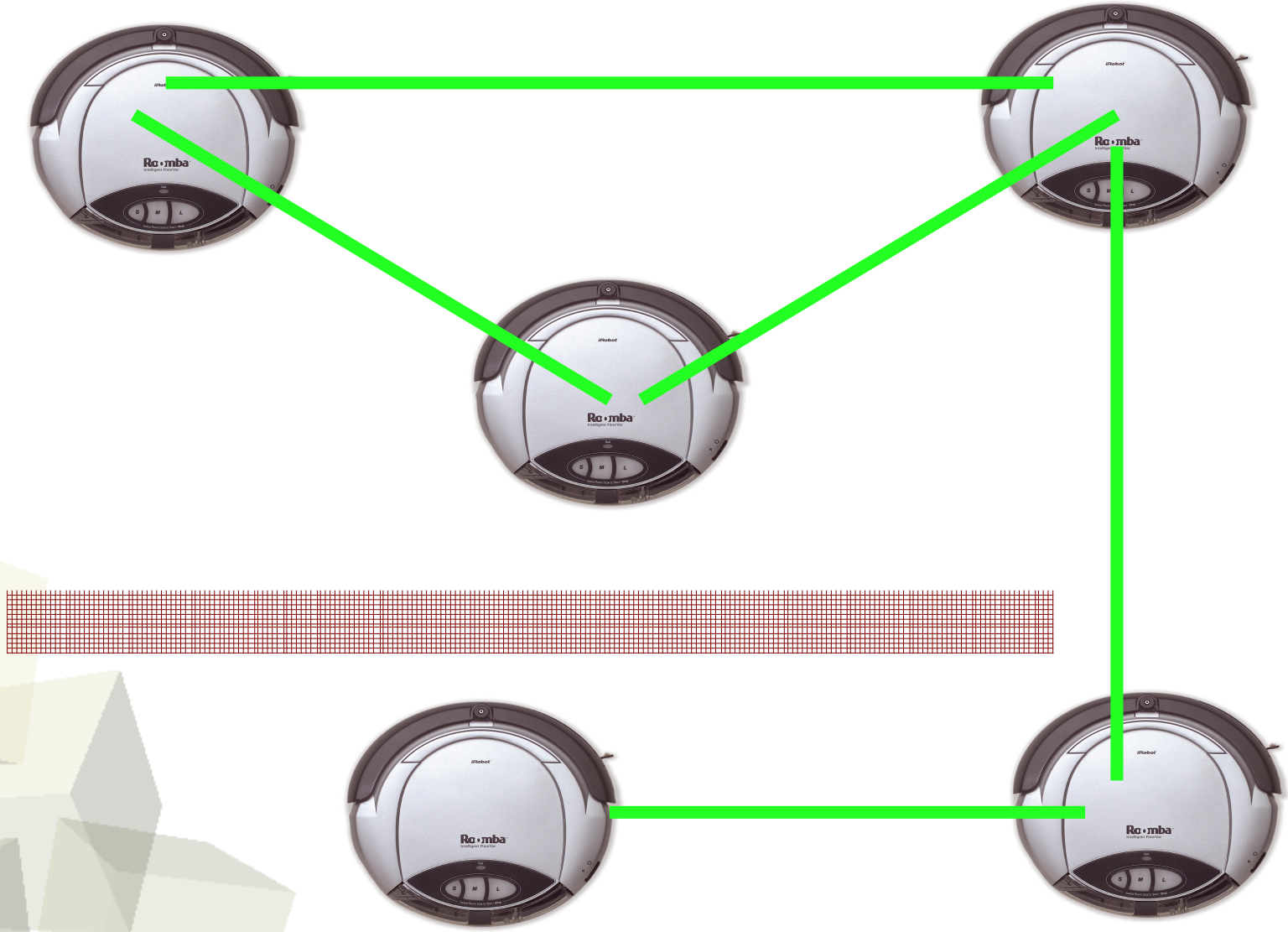
- Nodes may move relative to each other
- Nodes must stay connected
- Nodes must reorganize after topology changes
  - Movement/Failure
- Nodes should configure themselves in lowest power configuration

→ Very little work has been done on physically rearranging nodes automatically to meet above requirements

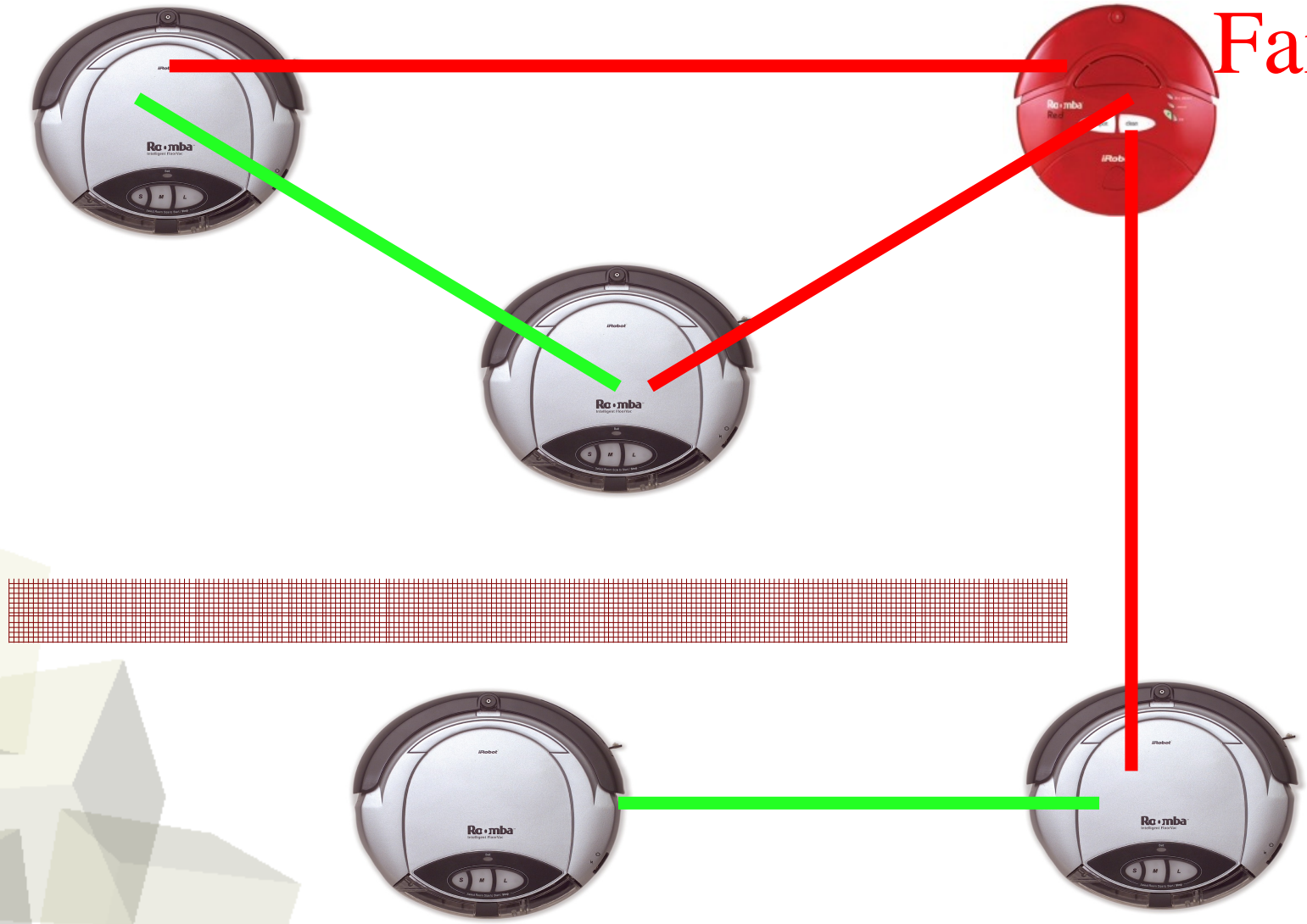
Example – Robotic floor cleaners

- Place a team of cheap robot floor cleaners around house
- Nodes communicate which areas are done
- Nodes may have different capabilities
  - eg, Wet Clean – to clean up liquid spills
- Nodes may need to call in help from other nodes to complete a certain task
- Nodes must co-operate to ensure connectivity between others at all times

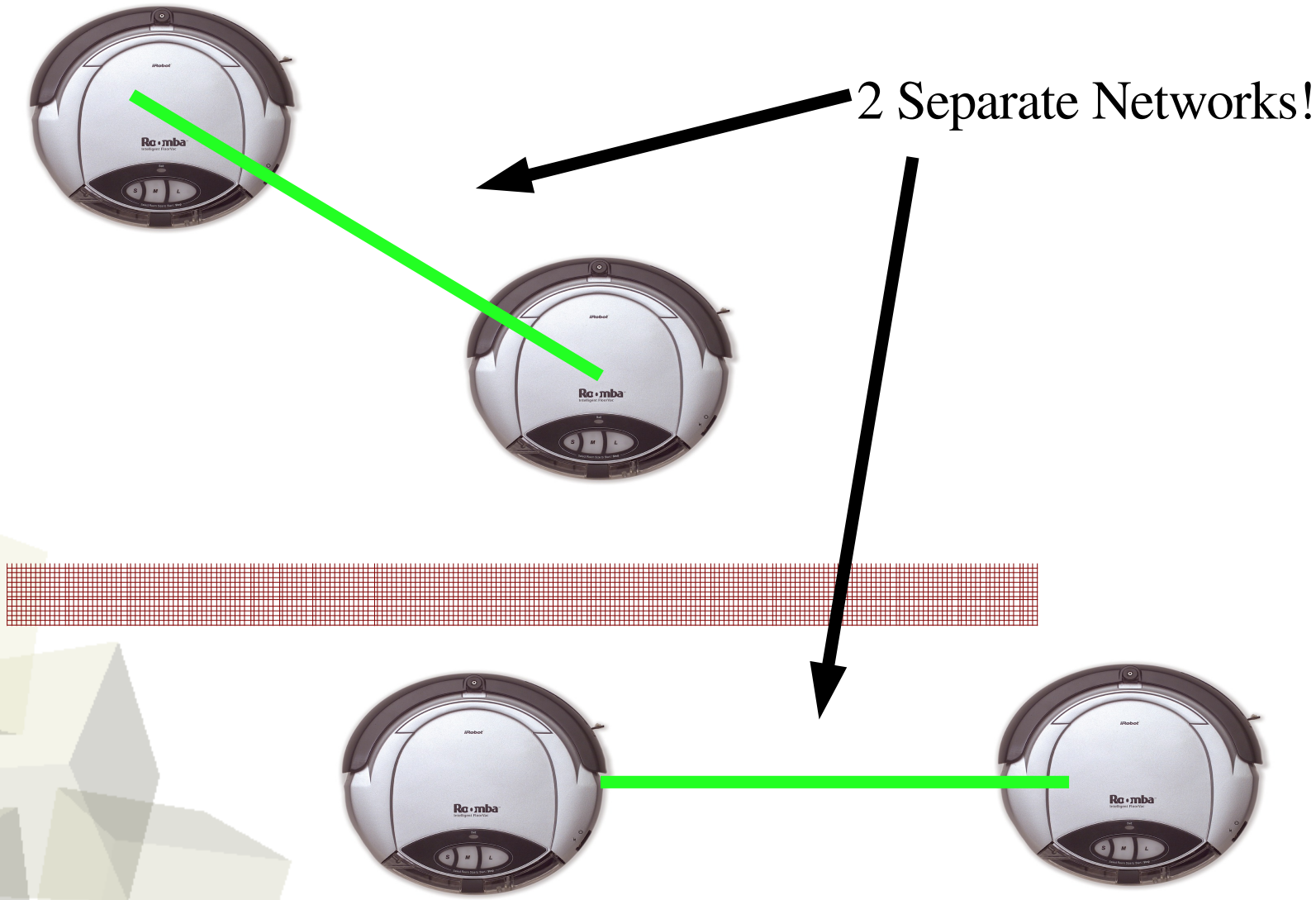
In House Ad Hoc Networks



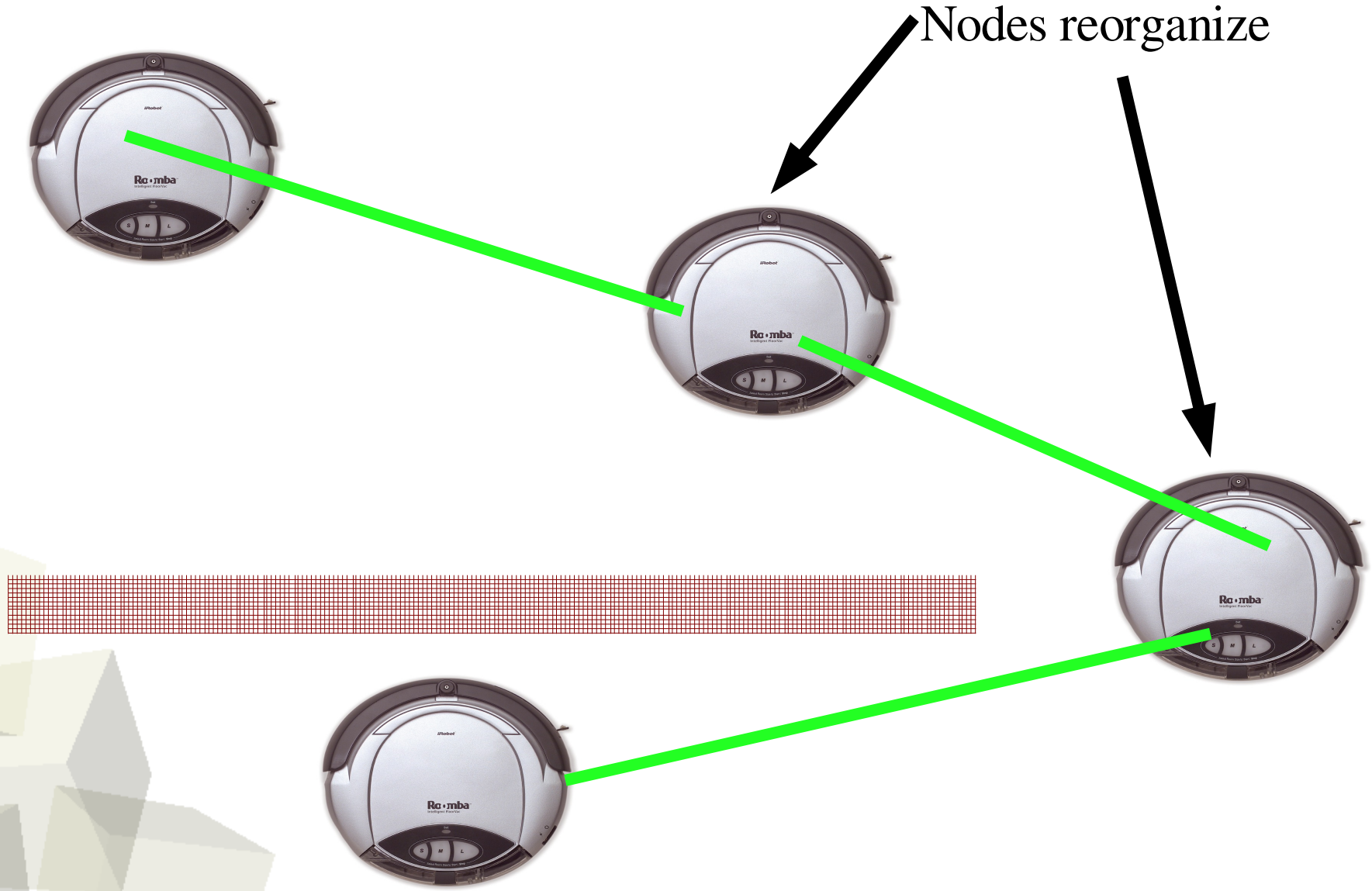
In House Ad Hoc Networks



In House Ad Hoc Networks



In House Ad Hoc Networks



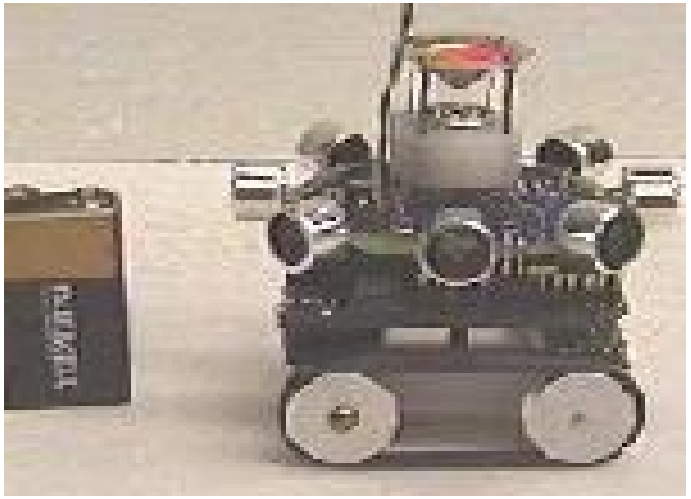
Beyond floor cleaners

- Mobile self-organizing nodes could be incorporated into current Wireless Sensor Networks (WSNs)
- Imagine WSNs monitoring bush fire activity, if a section of the network fails the connectivity of the network may be diminished
- The mobile nodes could change their position automatically try to “patch up” the network to ensure connectivity between all nodes

Similar Projects

- Gnats
  - Used for path finding
  - Non-Mobile (yet)
  - Do not re-organise topology
  - Use Infrared

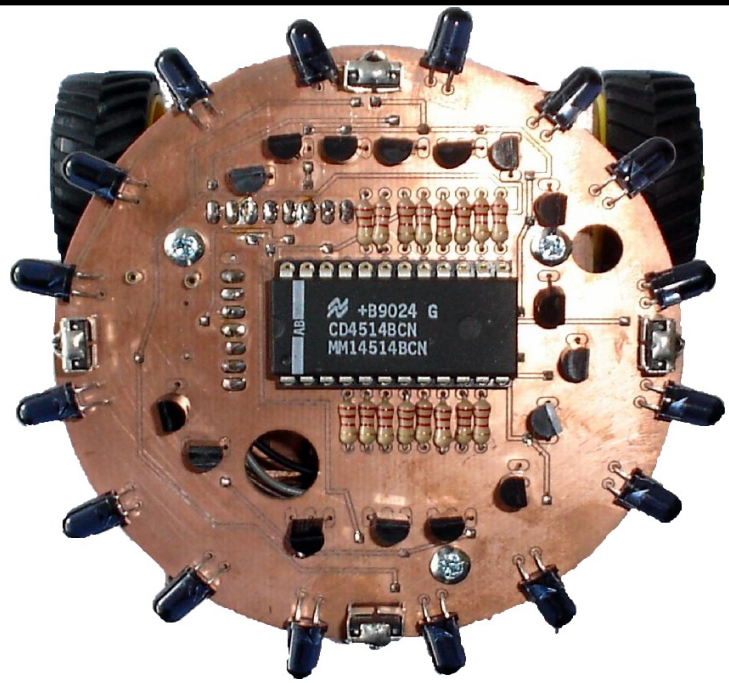
- Millibots
  - Used for path finding
  - Mobile
  - Not fully distributed
  - Use Radio and Ultrasonic



My Hardware

- ATMEGA168 Microcontroller
- Infrared -~1kbps
  - 16 TX leds (~20 deg. Beam)
  - 4 RX modules (90 deg. View)
  - Variable power output
  - Tested to ~10Meters
- 2 Motors – 2 PWM channels
- In System Programming
- Serial I/O

Why Infrared?



- Cheap
- Easy to use
- Line of sight
  - Localization - distance/angle
  - Robot assumes if it can see its neighbor it can move towards it
- Short distance
  - Easy to test in a small room
- Easy to control transmission power
  - Calculate approximate distance between nodes

Plans for mobile platform

- Develop more accurate understanding of IR for relative localization calculation
  - Preliminary results are encouraging
- Implement and test algorithms for self organization.
- Develop and test algorithms to form a lowest energy network

Future Plans – Beyond my platform

- Altera FPGA based
  - Allows more complex algorithms to be developed and tested
- IR-OFDM
  - May allow >100kbps transmission rates
- Incorporate nodes which know their absolute position
  - Each mobile node could determine its position

Extended Future Plans - (UAVs)

- Incorporate self organization system into UAVs
- Algorithms would be extended from 2D to work in 3D environments
- UAVs would physically arrange themselves automatically in 3D space
- Similar goals as 2D
  - Power efficient
  - Connectivity
  - Fault tolerant
  - etc...

Dr Price's Aircraft

Conclusion

My platform will be used for:

- Algorithm experimentation
  - Using the AVR micro-controller
- Localization
  - Using infrared intensity and angle
- Power control and energy optimization
  - Using variable transmission power

→ Combined with existing and new algorithms, these nodes will form a self-organizing, energy efficient wireless/mobile mesh network, ensuring seamless connectivity.

Questions