Steps to Assemble a MiNT Node

I. Hardware Components with Vendor List

The following list of equipments is a minimal set of items required to build a MiNT node. This list assumes that the user is familiar with some common terms, like soldering and the equipments necessary for performing the action, as well as, some items, like Velcro, used for fastening two objects.

A. Wireless Computing Platform

The following are the necessary items for building the wireless computing platform.

1) RouterBoard RB-230

   • Vendor: http://www.mikrotik.com
   • Comments: RouterBoard 230 is a small form-factor embedded computing board with 266 MHz CPU on it. The board does not come with any accessory, like the chassis which must be purchased separately from the same vendor. Hence, one must buy a Compact Flash card which is used as the non-volatile storage for storing the OS images, and other applications. If the storage requirement is high, then it is necessary to add a higher capacity disk on to the RouterBoard. The RouterBoard has a IDE port. Additionally, it is required to buy the RAM separately.

2) RB-14 PCI Extension Board

   • Vendor: http://www.mikrotik.com
   • Comments: Since there is only 2 slots for mini-PCI cards on the RB-230 it is required to buy this PCI adapter that allows connecting 4 mini-PCI cards to the RB-230. All the wireless cards we are using are mini-PCI cards. Additionally, because of size and design limitations of the RB-230 chassis, it is required to buy a PCI Riser card, RB-71 from the same vendor.

3) 2.5" Hard Disk

   • Vendor: Any standard disk manufacturer
   • Comments: This is the same hard disks used in laptops. It is advisable to check the Routerboard specification which clearly mentions the pin count of the disk. The IDE cable also needs to purchased separately for connecting the disk to the IDE connector on the board. Unfortunately, the RB-230 chassis is not designed well to accomodate a disk, hence requires some improvisation to place the disk inside the box.

4) Wireless Network Interface Cards

   • Vendor: http://www.netgate.com
   • Comments: The network interfaces have to be fitted with antennas, and that requires connectors. The connector types need to be carefully identified to make it easier to choose the antennas with connector types.

5) Fixed-point Attenuators

   • Vendor: http://www.hdcom.com
   • Comments: A point to remember while choosing the attenuators is that they are available for different frequency range of 2.4 GHz, and 5.8 GHz. While using 802.11a enabled wireless NICs, it is required to choose attenuators that can attenuate signals in the 5.8 GHz range. Secondly, since we are using fixed attenuators, it is useful to purchase multiple attenuators that can be combined to create various attenuation levels.

6) Low-gain Antennas

   • Vendor: http://www.netgate.com
   • Comments: These are 2.4-5.8 GHz Omnidirectional Swivel Antenna with cable and U.fl connector. With each choice of antenna careful attention must be paid to the connector types. The cable connecting the antenna to the wireless card should have the matching connector types to avoid use of additional adapters in between, which also leads to leakage of signal. In our design, we have the attenuators between the antenna and the card connector.

7) Battery

   • Vendor: Any portable laptop battery manufacturer
   • Comments: The tradeoffs in choosing a battery is the size/weight of the battery to battery lifetime before recharge. In our current setup,
we are using 118 Watt Hour Universal Li-Ion Laptop battery (NBMATE-118).

B. Mobility Platform

The following items are required for building the remote controlled mobility platform.

1) Roomba Robotic Vacuum cleaner
   • Vendor: http://www.irobot.com
   • Comments: These are standard Roomba vacuum cleaner available from any consumer electronics shop at retail price of $249.

2) SpitFire Universal Remote Controller
   • Vendor: http://www.SmartHomeUSA.com
   • Comments: The Universal remote controller can be fitted with an extension cable to for pin-pointing the IR beam to specific directions. This is a stick-on block with a very small size that is useful in the overall assembly of a MiNT node.

3) Diodes
   • Vendor: RadioShack
   • Comments: Diodes with reasonably high rating as available in RadioShacks for hobby electronics is required for devising the common charging circuitry of the Roomba battery and the laptop battery used for charging the RouterBoard (refer Figure ??).

II. ASSEMBLY INSTRUCTIONS

This section covers the assembly instructions for putting together the items mentioned in Section I for building a stand-alone MiNT node.

A. Hardware Assembly Instructions

A MiNT node is assembled in completely modular fashion. The steps involved in assembling a node are: (a) assembly of the wireless computing box, (b) assembling the mobility platform, including the universal remote controller device, (c) putting modules (a) and (b) together.

1) Wireless Computing Platform Assembly Instructions:
   1) Open RouterBoard chassis and insert the memory module on to the RB-230. The CF card can also be inserted at this point if an image has already been burnt into it for booting using that image. Otherwise, it is possible to insert the CF card later. It is required to burn an image into the CF card and that requires any available card reader.

2) The PCI riser card, RB-71 is placed on the PCI slot on the board. The PCI-to-miniPCI adapter, RB-14 is connected to the riser card. Four miniPCI wireless NICs are placed on to the slots on the RB-14. Before placing the cards in the slots, it is advisable to attach the connectors securely (if needed it is better to use clear tapes to secure the connector end that sits on the NIC).

3) The placement of the hard disk inside the chassis requires some improvisation because the chassis is not designed for placing a hard disk. A suitable place to attach the hard disk is on the smaller side of the box near the IDE connector on the board. To secure the hard disk in the chassis, two small grooves are cut on the box, and for cooling purpose a hole is drilled on the body of the chassis. Remember to put the jumpers on to the disk because the disk will appear as the slave, and the CF card is the master.

4) 2 openings on each of the longer sides of the chassis is created to allow for the antenna connectors to come out.

2) Mobility Platform Assembly Instructions:

1) The Roomba battery charges when it places itself on the docking station. While the Roomba battery we charge the laptop battery simultaneously. First, figure out the positive and negative charging leads on the Roomba by measuring the voltage using a multimeter. Next, solder a diode to the +ve lead on the Roomba to prevent the Roomba from drawing current from the laptop battery. Solder another wire to the -ve end. The other end of the +ve and -ve cable goes to a coaxial charging tip that plugs into the laptop battery for charging (refer Figure ??).

2) Since the laptop battery charges both the Routerboard and the Universal Remote control device (Spitfire), therefore we need a Y-connector (available in RadioShack). With proper charging tips connected to the other end of the Y-connector, we can charge both the devices from the same battery.

3) For programming the universal remote control device, one spitfire must be programmed manually using the remote control of the Roomba. The Roomba codes for different actions are recorded in one Spitfire. We require all the Spitfires to send out exactly same signals. In order to remove any perturbation that may happen while training several Spitfires separately and manually, it is advisable to use a chip programmer device to copy the learned
code (stored in EEPROM – ATMEL chip) onto the other Spitfires. Finally, the IR extender is used to stick the IR emitting block to the Roombas IR receiver.

3) Putting It All Together:

1) In order to place the entire setup on the Roomba, it is necessary to create a two-layer rack. Choose a suitable stackable rack and fix it onto the Roomba using screws. We use stackable wiremesh trays for the purpose. Ensure that the placement of the trays does not hinder free movement of any part of the Roomba, specially the head.

2) The battery and the Spitfire is placed on the lower rack. The Routerboard is placed on the top rack. The antennas are placed on four corners.

B. Software Installation Tips

The RouterBoard RB-230 can be booted with a distribution, called the pebble distribution from http://www.nycwireless.com. The driver used for the wireless cards is available from http://madwifi.org. The driver is specific for cards using Atheros based chipset.

During the network setup, it is useful to allow one interface to acquire a DHCP address so that the device is accessible as soon as it boots up.