Bluetooth for Ad-Hoc Networking

Foundation of Bluetooth distributed localization system

1 Introduction

The present invention relates generally to communication networks and more specially to the use of location determination and tomography methods and structures in wireless communication networks.

A wireless ad hoc network (WANET) is a decentralized type of wireless network. The network is ad hoc because it does not rely on a pre-existing infrastructure, such as routers in wired networks or access points in managed (infrastructure) wireless networks.

Peer-to-peer network location resolution is an emerging market Within the Wireless communication arena. New systems are being developed to and people and/or objects, in indoor and outdoor environments. For outdoor environments, there are many solutions that can provide very high-resolution location estimates. In building location solutions, however, techniques are still being researched and developed. Many indoor location determination solutions operate on radio frequency signals and require a dense installation of receivers that can make signal-strength measurements that are used to determine the transmitter’s location. Recently, Bluetooth has been considered a viable solution in the quest to define an indoor solution.

2 Principle

2.1 Piconet Topology

Any time a Bluetooth wireless link forms, it is within the context of a piconet. A piconet consists of two or more devices occupying the same physical channel (synchronized to a common clock and hopping sequence). The common (piconet) clock is identical to the Bluetooth clock of one of the devices in the piconet, known as the master, and the hopping sequence is derived from the master's clock and the master's Bluetooth device address. All other synchronized devices are slaves in the piconet. The terms master and slave are used only when describing these roles in a piconet. Within a common location, a number of independent piconets may exist. Each piconet has a different physical channel (that is a different master device and an independent piconet clock and hopping sequence).

A Bluetooth enabled device may participate concurrently in two or more piconets. It does this on a time-division multiplexing basis. A Bluetooth enabled device can never be a master of more than one piconet (since the piconet is defined by synchronization to the master's Bluetooth clock it is impossible to be the master of two or more piconets). A Bluetooth enabled device may be a slave in many independent piconets.

A Bluetooth enabled device that is a member of two or more piconets is said to be involved in a scatternet. Involvement in a scatternet does not necessarily imply any network routing capability or function in the Bluetooth enabled device. The Bluetooth core protocols do not, and are not intended to offer such functionality, which is the responsibility of higher-level protocols and is outside the scope of the Bluetooth core specification. Logical transports, logical links and L2CAP channels provide capabilities for the transport of data.

2.2 RSSI

In telecommunications, received signal strength indicator (RSSI) is a measurement of the power present in a received radio signal

RSSI is usually invisible to a user of a receiving device. However, because signal strength can vary greatly and affect functionality in wireless networking, IEEE 802.11devices often make the measurement available to users.

RSSI is often done in the intermediate frequency (IF) stage before the IF amplifier. In zero-IF systems, it is done in the baseband signal chain, before the baseband amplifier. RSSI output is often a DC analog level. It can also be sampled by an internal ADC and the resulting codes available directly or via peripheral or internal processor bus.

3 How it works

Bluetooth piconets utilize frequency hopping: 79 frequencies are used and they change frequencies 1600 times per second. They use an assigned frequency of 2.45 GHz, a frequency set aside for this purpose by the ISM (Industrial Scientific and Medical) frequency band.

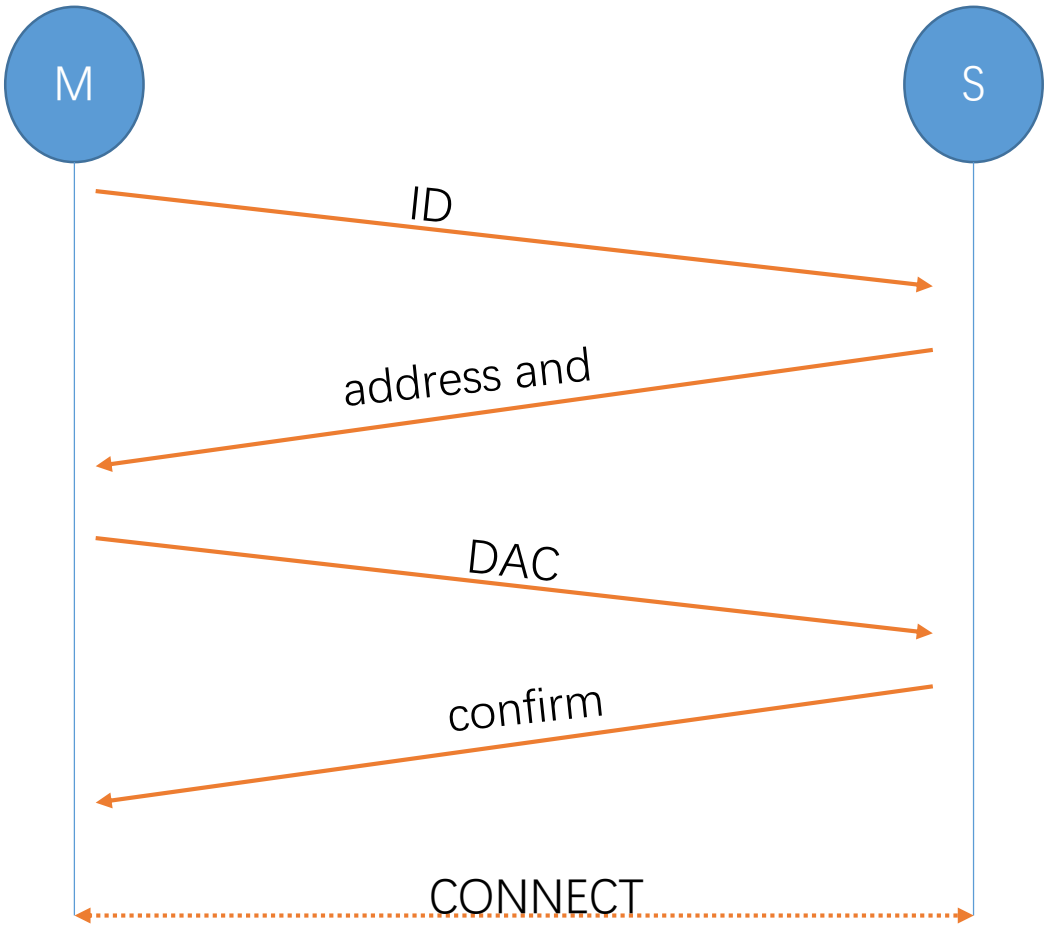
Since, each piconet has a unique master with its unique Bluetooth device address (BD_ADDR) as well as its own clock, therefore, each piconet has its unique frequency hopping sequence. When a connection is initiated by Bluetooth enabled devices, the master device’s clock along with the device address (BD_AAR) is transmitted to the slave devices in a packet known as Frequency-Hop Synchronization Packet (FHS packet).

The device address of the master device is used to calculate the sequence of frequency hops which all devices within a piconet, follow. The clock of the master device assigns the sequence of the frequency hops. All devices within a piconet use the difference

between their own native clock and the master's native clock to make use of particular frequency in order to transmit or receive radio signals on a particular moment.

Using this method, the Bluetooth devices within a piconet are able to avoid one another's transmission by persistently changing frequency channels.

- The master transmits an ID packet.
- Devices in the STANDBY state periodically scan for this packet. If it hears it, the device sends its address and timing info to the master. The device then waits for the master to page it.
- When the master is satisfied that it has identified all the devices in its range it starts to form the piconet. It pages each device with its own device access code (DAC) using a frequency hopping sequence based on the slaves address.
- When the slave hears this it sends a confirmation packet.
- On the next slot the master sends the slave the master DAC. The slave then enters the CONNECTION state. The master does this for all the slaves in the piconet then it enters the CONNECTION state itself.



4 Future work

Build a distributed localization system. The seven wireless devices of the piconet each determine the RSSI data and path loss. One of the seven devices, serving as a super master device, collects all the RSSI info. Grouping this information on each path gives an improved estimate of the locations of any absorbers within the piconet.