

Wireless Module Research

Introduction

Wireless communication is common-place, but the frequency bands, protocols used, and features available vary widely on the wireless technology used. Implementing wireless communication in any project starts with the specification of functional requirements for the given project. However, a general understanding of the available wireless modules will help with the selection process. This whitepaper intends to provide a general overview of wireless technologies available for implementation into a project.

Intended Applications

The focus of this whitepaper is the application of wireless communication to a system that requires data flow between a remote device (usually a sensor or sensing device) and a central device or repository (usually a computer). The goal is to identify and evaluate COTS equipment to be used for the communication portion of the project. Specifically, the goal is to minimize the development time to provide wireless communication to the project by identifying devices that “plug-and-play” into an already designed system—these are generally referred to as “modules.”

Disclaimer

The information contained in this whitepaper is intended for use by Infotek International, Inc. engineers, and while the intention is to provide a general overview and a detailed review of available modules, the information contained should be considered transitory and incomplete.

Wireless Communication Techniques

There are many different technologies available for wireless communication that is limited largely by the governmental allocation of communication bands. The major types of wireless communication are radio frequency (RF) communication, personal area networks (PAN)--both narrow band and ultra wide band (UWB), local area networks (LAN), cellular networks, and satellite networks. There are any number of standards and technologies contained within each major type. For example, PAN include Bluetooth, Zigbee, Certified Wireless USB, among other specifications.

For the purposes of this whitepaper, cellular and satellite networks will be ignored because they require considerable infrastructure to be in place or they require a subscription service to use the currently available services. The following section provides a high-level comparison of the different technologies. The features of interest for each are frequency range, possible applications, relative communication range, relative cost, availability of modules, availability of extended features, and complexity of development.

High-level Comparison

1. Simple RF: simple RF in the ISM band using a keying algorithm is common for keyfobs, low-bandwidth remote sensor systems, remote control, and other relatively simple systems. Can run at multiple frequency, but ~400 MHz and ~900 MHz ranges are what we would likely use.

- Advantages:
 - Simple (relatively)
 - Inexpensive (presumably)
 - Widely available modules (hopefully)
- Disadvantages:
 - Simple (probably doesn't support advanced features like multi-point connections, security, and alternate configurations).
- 2. Wireless networking (802.11[b,g,n]): wireless networking is widely available and commonly used. Generally, runs at 2.4 GHz.
 - Advantages:
 - Widely available
 - Standardized
 - Some advanced features are available
 - May be possible to integrate reel-less components into existing equipment
 - Disadvantages:
 - Overhead required in protocols
 - Potential conflicts with other wireless network devices
- 3. Bluetooth: Bluetooth is a “personal” networking protocol designed to standardize connections between devices. It operates at 2.4 GHz.
 - Advantages:
 - Widely available and becoming common for some devices (cell phones, headsets, PDAs)
 - Standardized
 - Advanced features available (security, multi-point, etc.)
 - Disadvantages:
 - Maybe more expensive (most modules seem to be \$20 or more—possibly up to \$80 or more)
 - Additional overhead
- 4. ZigBee: ZigBee is a standard (802.15.2) for personal area networks, specifically targeted to remote control and monitoring. It is relatively new, but seems to be growing in acceptance. It operates in the 2.4 GHz range.
 - Advantages:
 - Reasonable availability
 - Standardized
 - Advanced features (security, multi-point, multiple configurations, etc.)
 - Reasonably inexpensive (most modules seem to be \$10 to \$30)
 - Disadvantages:
 - Additional overhead
 - Not as widely used as Bluetooth or wireless networking.

Specific Modules

Linx RF Modules

Linx Technologies (www.linxtechnologies.com) offers transmitter and receiver chips, specifically:

1. TXM-418-LC
2. RXM-418-LC-S
3. TXM-433-LC
4. RXM-433-LC-S

Advantages:

- single-chip component contains all RF components except for antenna
- easy to implement FSK using Manchester encoding
- development kit already available

Disadvantages:

- encoding is done in software

Cost (on 17 January 2007 via www.digikey.com):

- TXM-418-LC is \$6.90
- TXM-433-LC is \$6.90
- RXM-418-LC is \$13.79
- RXM-433-LC is \$13.79

Note: according to Linx website, the 433 version is not recommended for new designs (I believe it is end-of-life product), and Digikey does not have many in stock at the time of checking.

Linx also offers an LR series of chips that are similar to the LC series, but supposedly more stable. Pinouts are mostly the same.

They also offer a combined encoder/TX and decoder/RX series called the KH series. These run \$9.98 for TX and \$15.93 for RX. This might be a plausible solution since we avoid software encoding of the data.

Applied Wireless RF Modules

Applied Wireless has a series of FM/FSK RF modules available that run from 902 MHz to 928 MHz range. These are paired RX/TX modules.

Advantages:

- no RF design required
- FSK on chip, so they should be easy to use

Disadvantages:

-

Cost (according to their pricelist on 17 January 2007)

- T900FM is \$23.95
- R900FM is \$39.00

Note: this seems to be relatively expensive.

Radiometrix RF Modules

Radiometrix has a pair of RX/TX modules in both the 868 MHz and 916 MHz ranges. These appear to be drop-in RF modules without any encoding; however, I couldn't find any pricing information, and it appears to be primarily a European company.

Semtech XE Transceiver

Semtech has a transceiver that operates in either 433, 868, or 916 MHz frequency ranges. It seems that each range has a set of channels that can be assigned to each transceiver, so multiple transceivers could be used within the system. The chip includes FSK.

Advantages:

- single-chip solution
- multiple channels within same chip
- FSK on-chip

Disadvantages:

- more complicated design (although it still appears pretty simple)

Cost (from Digikey on 17 January 2007):

- XE1203 is \$9.90
- XE1205 is \$5.26 (in quantity)

Note: these are also available in “modules” but these seem to be very expensive (~\$110 or more).

Also, I'm not sure what the difference is, either between the QFN package and the module or between the 1203 and 1205.

Amtel Transceivers

Amtel has a series of transceivers, ATA54XX (5423, 5425, 5428, 5429) that provide UHF band RF communication with ASK/FSK encoding. The different models run at different frequencies with (I believe) multiple channels at each frequency. These sound like a relatively easy chip to use, and they may make a nice drop-in replacement for the Linx chips.

Advantages:

- single-chip solution
- multiple channels within same chip

- transceiver, so it may support some future functionality
- ASK/FSK on the chip

Disadvantages:

- ???

Cost (from Digikey on 19 January 2007):

- ATA5423 is \$7.07 (315 MHz)
- ATA5425 is \$7.07 (345 MHz)
- ATA5428 is \$7.07 (433/868 MHz)
- ATA5429 is \$7.70 (915 MHz)

KC Wirefree Bluetooth Modules

KC Wirefree offers several Bluetooth modules. These modules range in size, I/O capability, and range (3 modules with 20 meter range and one with 100 meter range).

Advantages

- Advanced features available through Bluetooth standard, specifically multi-point connections, security, encryption, etc.

Disadvantages

- ???

Cost (not available on their website)

- Personal conversations indicate the modules are relatively inexpensive (\$10 or \$20), but the company has been unresponsive to quote requests. Their evaluation kits are reasonable, so the modules are likely reasonable as well.

Cirronet Bluetooth Modules

Cirronet resells Bluetooth modules manufactured by BlueGiga. These modules range from simple Bluetooth to fully-integrated module (including stack and OEM board connections).

Advantages

- Modules range in complexity depending on module
- Advanced features available through Bluetooth standard, specifically multi-point connections, security, encryption, etc.

Disadvantages

- Modules range in complexity, so selecting the right module will have an impact on design time

Cost (not available on their website)

- Evaluation kits are more expensive than others, so it is assumed that these modules are slightly more expensive.

Cirronet ZigBee Modules

Cirronet offers two ZigBee modules—it seems that 802.15.4 is also supported but the website is not clear; however ZigBee depends on it, so it probably is. The two modules are a standard (ZMN-2400) and a high-power version (ZMN-2400HP). The range is not identified for either.

Advantages

- Simple to include in design
- Multiple modules to select depending on requirements
- Advanced features available through ZigBee standard, specifically multi-point connections, security, encryption, etc.

Disadvantages

- Designed for use in ZigBee PAN—may not be available for other uses.

Cost (not available from their website)

- Evaluation kits are more expensive than others, so it is assumed that these modules are slightly more expensive.

MaxStream ZigBee Modules

MaxStream offers a couple ZigBee modules that offer 802.15.4 and/or ZigBee standard support. The standard module offers 100 meter range while the “PRO” module offers 1 mile range with both devices operating in the 2.4 GHz band.

Advantages

- Simple to include in design
- Multiple modules to select depending on range requirements
- Multiple standards support depending on requirements
- Advanced features available through the standards, specifically multi-point connections, security, encryption, etc.

Disadvantages

- Designed for use in 802.15.4 or ZigBee PAN—other uses require significant development time

Cost (from MaxStream website as of 18 June 2007)

- XBee OEM Module is \$19 (2.4 GHz, 100 m range)
- XBee PRO OEM Module is \$32 (2.4GHz, 1 mile range)

MaxStream RF Modem Modules

MaxStream offers a series of RF modem modules for wireless communication. Their 1 Watt module claims 40 mile range. The modules operate in the 900 MHz band (one also operates at 2.4 GHz), and they are designed to be drop-in serial replacement.

Advantages

- Simple to include in a design
- Multiple modules to select depending on range and data rate requirements
- Multiple bands to choose from (both 900 MHz and 2.4 GHz)

Disadvantages

- Fairly expensive
- Lower data rates than other available modules

Cost (from MaxStream website on 18 June 2007)

- XCite OEM Module is \$40 (900 MHz, 300 m range)
- XStream OEM Module is \$150 (900 MHz or 2.4 GHz, 20 mile range)
- XTend OEM Module is \$179 (900 MHz, 40 mile range)