IrDA and Bluetooth
A Complementary Comparison

by David Suvak

Bluetooth and IrDA are two similar technologies with their own individual strengths and weaknesses. This article provides a complementary comparison of the two to help determine which transport better serves a given application. By giving an overview of the two technologies followed by a discussion of sample usage models, the developer can understand how the technologies differ and where they overlap. Also included is a comparison of the implementation costs and regulatory requirements for both technologies. This article furnishes a complete framework of considerations needed to select the appropriate technology required for a given application.

What is IrDA?

The Infrared Data Association (IrDA) specifies three infrared communication standards: IrDA-Data, IrDA-Control, and a new emerging standard called AIr. Since this document focuses on IrDA-Data and its relationship to Bluetooth, for the purpose of this document, IrDA refers to the IrDA-Data standard. In general, developers use IrDA to provide wireless connectivity technologies for devices that would normally use cables for connectivity. IrDA is a point-to-point, narrow angle (30° cone), ad hoc data transmission standard designed to operate over a distance of 0 to 1 meter and at speeds of 9600 bps to 16 Mbps.

General IrDA characteristics

The general IrDA characteristics include:

- Proven worldwide universal cordless connection
- Installed base of over 50 million units
- Wide range of supported hardware and software platforms
- A design for point-to-point cable replacement
- Backward compatibility between successive standards
- Narrow angle (30 degree) cone, point-and-shoot style applications (non-interference with other electronics and low-level security for stationary devices)
- High data rates: 4 Mbps currently, 16 Mbps under development

What is IrDA used for?

The following devices use IrDA to transmit data:

- Notebook, desktop, and handheld computers
- Printers
- Phones and pagers
- Modems
- Cameras
- LAN access devices
- Medical and industrial equipment
- Watches

Worldwide acceptance

With a worldwide installed base of over 150 million units and growing at 40% annually, IrDA is widely available on personal computers, peripherals, embedded systems, and devices of all types. In addition, the wide use and acceptance of IrDA standards and robust solutions have accelerated adoption of the IrDA specifications by other standards organizations. The universal adoption and worldwide implementation of IrDA specifications guarantees a universal hardware port and rapidly emerging software interoperability.

What is Bluetooth?

Bluetooth is a Radio Frequency (RF) specification for short-range, point-to-multipoint voice and data transfer. Blue-tooth can transmit through solid, non-metal objects. Its nominal link range is from 10 cm to 10 m, but can be extended to 100 m by increasing the transmit power. Bluetooth is based on low-cost, short-range radio links, which facilitate ad hoc connections for stationary and mobile communication environments.

General Bluetooth characteristics

The general Bluetooth characteristics include:

- Operates in the 2.4 GHz Industrial-Scientific-Medical (ISM) band
- Uses Frequency Hop (FH) spread spectrum, which divides the frequency band into a number of hop channels; during a connection, radio transceivers hop from one channel to another in a pseudo-random fashion.
- Supports up to eight devices in a piconet (two or more Bluetooth units sharing a channel)
- Built-in security
- Non-line-of-sight transmission through walls and briefcases
- Omni-directional
- Supports both isochronous and asynchronous services; easy integration of TCP/IP for networking
- Regulated by governments worldwide

What is Bluetooth used for?

Bluetooth enables users to connect to a wide range of computing and telecommunications devices without the need to buy, carry, or connect cables. It delivers opportunities for rapid, ad hoc connections, and in the future, possibly for automatic, unconscious connections between devices. Bluetooth's power-efficient radio technology can be used in many of the same devices that use IR, such as:

- Phones and pagers
- Modems
- LAN access devices
- Headsets
- Notebook, desktop, and handheld computers

Reprinted from PC/104 Embedded Solutions / Fall 2000

IrDA and Bluetooth
A Complementary Comparison

Manufacturers' acceptance

Bluetooth enables wireless, portable electronic devices to connect and communicate via short-range ad hoc networks. A universal radio interface in the 2.45 GHz frequency band has gained the support of Ericsson, Nokia, IBM, Toshiba, Intel, and over 1700 other manufacturers. In order to function on a worldwide basis, Bluetooth requires a radio frequency that is license-free and open to any radio. The 2.45 GHz ISM band satisfies these requirements, although it must cope with interference from baby monitors, garage door openers, cordless telephones, and microwave ovens, which use this frequency.

IrDA and Bluetooth application overlap

The application spaces of Bluetooth and IrDA overlap (see Figure 1). Many of the applications defined for IrDA are also defined for Bluetooth. Yet, there are situations and conditions where IrDA is better suited for transmitting data than Bluetooth and vice versa.

Data exchange

Both IrDA and Bluetooth consider data exchange to be a fundamental function. Data exchange can be as simple as pushing a business card from a mobile phone to a PDA or as sophisticated as synchronizing personal information between a PDA and a PC. Bluetooth and IrDA specify both these applications as well as other data exchange applications. Both use the same upper layer protocol (OBEX) to implement these applications. IrDA and Bluetooth intend to use the same data exchange applications when appropriate. By using the same upper level protocol, it is possible for a single application to run over both Bluetooth and IrDA. It may seem that if IrDA and Bluetooth can support the same applications, then why have both technologies? The answer lies in the fact that each technology has its pluses and minuses. Fortunately, the very scenarios where IrDA falls short are the ones in which Bluetooth excels and vice versa. A common data exchange scenario is one in which the exchange will take place in a room containing a number of other devices. An example is electronic business card exchange. Two people meet to exchange business cards, face to face, in a large conference room. Many other people carrying wireless devices are also present in the room, possibly attempting to do the same thing. This is the situation where IrDA excels. The short-range, narrow angle of IrDA allows the user to aim in a point-and-shoot style at the intended recipient. Close proximity to the other person is natural in a business card exchange situation, as is pointing one device at another. The limited range and angle of IrDA allows others to perform a similar activity without interference. The short-range and narrow angle of IrDA provides a simple form of security and a natural ease of use.

This same situation is a weakness for Bluetooth. With its omnidirectional characteristic, Bluetooth has problems discovering the intended recipient. It does not allow the user to simply point at the intended recipient. A Bluetooth device must perform a time-consuming discovery operation that will find many of the other devices in the room. Close proximity to the intended recipient will not help. The user will be forced to choose from a list of discovered devices. Choosing the proper device will probably require special information from the other person (e.g., a 48-bit device address or friendly name). Also Bluetooth has multipoint

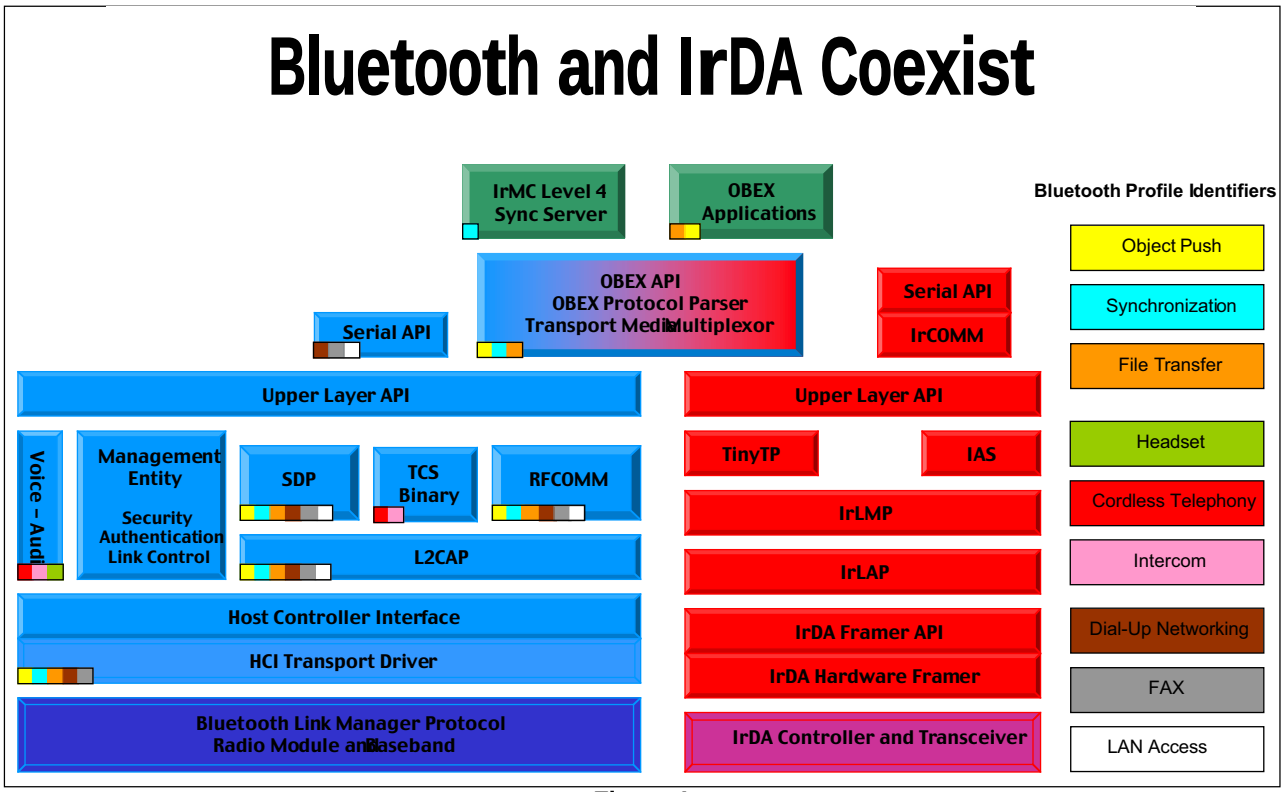

Figure 1

capabilities and therefore uses security mechanisms to prevent unauthorized access. The two users attempting to perform a business card exchange using Bluetooth may also need to execute security measures.

In other data exchange situations, Bluetooth is the obvious choice. Bluetooth's ability to penetrate solid objects and its capability for maximum mobility within the piconet allows for data exchange applications that are very difficult or impossible with IrDA. For example, with Bluetooth a person could synchronize their telephone with a PC without taking the telephone out of their pocket or purse (this is not possible with IrDA). The omni-directional capability of Bluetooth allows synchronization to start when the telephone is brought into range of the PC. Using Bluetooth for synchronization does not require that the telephone remain in a fixed location. If the person carries the telephone in his pocket, the synchronization can occur while he moves around. With IrDA, the telephone must be placed in the proper location and remain stationary while the synchronization executes.

LAN access

An important feature of both Bluetooth and IrDA is the ability to connect a wireless device to a wired network. Because there are no line-of-sight requirements for Bluetooth devices, they are well suited for this type of application. Users of Bluetooth have a higher level of flexibility when placing a LAN access point within the premises when compared to IrDA. In addition, Bluetooth's multipoint capability allows multiple devices to efficiently share the media. The one potential area of weakness for Bluetooth, when compared to IrDA, is performance. Bluetooth's aggregate bandwidth is limited to 1 Mbps, while IrDA supports 4 Mbps with 16 Mbps under development.

IrDA specifies the IrLAN protocol for connecting an IrDA-enabled device to a wired network. IrDA requirements for line-of-sight and maximum distance of one meter must be taken into account when placing IrLAN access devices. In addition, once an IrDA device is connected to the LAN, it must remain relatively stationary.

Dial-up networking

Emulating an EIA/TIA 232 connection between a portable computer and a mobile phone for establishing a dial-up connection to the Internet is a common use of IrDA today. An IrDA connection works well for this type of application. This is also an application targeted by Bluetooth. Bluetooth's primary advantage is that the user can leave the mobile phone clipped to his belt or in a pocket and walk around for the entire dial-up connection. Bluetooth technology does not require that the telephone be positioned near any other device, as is required by IrDA.

Voice applications

A native feature of the Bluetooth specification is the synchronous voice channel feature. Bluetooth has the ability to reserve bandwidth for carrying digital voice data. Bluetooth can support as many as three simultaneous, full duplex voice conversations within a piconet. A component of the Infrared for Mobile Communications (IrMC) specification includes RTCON, which is a specification for transmitting full duplex voice data over an IrDA link. RTCON consumes the full bandwidth of a 115.2 Kbps IrDA link so as not to allow multiplexing of other data. IrDA works well for this type of application if both sides of the link are in fixed positions relative to each other. The most common application involves a mobile phone placed in a hands-free car cradle.

Security issues

The directional nature of IR imposes a form of low-level security because it requires direct line-of-sight between transmitter and receiver. However, it is possible to eavesdrop on a conversation by detecting reflected light and filtering out the surrounding ambient noise. IrDA does not provide security capabilities at the link level, as provided by Bluetooth. Instead, IrDA relies on upper level protocols and applications to provide authentication and/or encryption.

Because Bluetooth is omni-directional, a snooping device can monitor it from any direction, including hidden locations. Bluetooth addresses this issue by providing authentication and encryption in its base-band protocol. Authentication relies on a challenge-response protocol using a secret key (password or PIN). Both devices must contain the same secret key. The protocol allows each device to authenticate the other. After authentication, it is possible to encrypt the transmission for added security.

RF and IrDA implementation costs

Implementing IrDA in consumer devices is very simple. Some manufacturers have completely integrated IR packages. IrDA controllers are simple to include as well. Device manufacturers can get a complete solution for about one U.S. dollar. The cost of integrating IR into a device can be as little as two dollars in the U.S. Since Bluetooth devices are not yet widely available, it is difficult to estimate component costs of implementing Bluetooth into a device. Initial projections are $20 in the U.S. for first generation devices, with future devices being targeted for around $5 in the U.S. within a few years.

IR and RF technology regulation

IR technology is mostly unregulated, but with the concern over eye safety with laser diodes and LEDs, the IEC-825-1 eye safety standard was recently amended to include all LED-based transceivers. The current IrDA specifications are well within IEC guidelines, but care must be taken as new IrDA specifications with greater range and bandwidth are created. New specifications will need to be verified against the IEC standards.

As an RF technology, Bluetooth is subject to worldwide regulatory groups. The vast majority of the world recognizes and allows unlicensed use of the ISM 2.45 GHz band for devices, but there are exceptions. France, Spain, and Japan are addressing issues surrounding Bluetooth, but it is unlikely that they will resolve every issue before Bluetooth products begin to appear.

Summary

IrDA and Bluetooth technologies provide complementary implementations for data exchange and voice applications. For some devices, having both Bluetooth and IrDA will provide the best short-range wireless solution. For other devices, the choice of adding Bluetooth or IrDA will be based on the applications and intended usage models. The story on short-range wireless communication technology is still being written, and IrDA and Bluetooth will be the major forces driving this area.

David Suvak *has been involved with the Infrared Data Association (IrDA) since its beginning. At Hewlett-Packard, he was involved in implementing the HP/Microsoft Windows 95 IrDA solution. David subsequently left HP and co-founded Counterpoint Systems Foundry, Inc. (now Extended Systems/ Counterpoint) to make IrDA software solutions for embedded systems and non-PC platforms. Extended Systems/Counterpoint is also a Bluetooth adopter and David is an active participant in the Bluetooth Software working group. Extended Systems/ Counterpoint is heavily involved in the ongoing development of wireless standards and technologies. Extended Systems/ Counterpoint products are available for major Real Time Operating Systems (RTOSs), Windows, DOS, and stand-alone configurations.*

Reprinted from PC/104 Embedded Solutions / Fall 2000

For more information on this article, contact David at the following address:

Extended Systems
5777 North Meeker Ave.
Boise ID 83713
Tel.: 208-322-7575 • Fax: 208-377-1906
Email: info@countersys.com
Web site: www.extendedsystems.com