Bluetooth Technology for the Field Surveyor

Peter Large

Trimble Integrated Surveying Group,
Westminster, Colorado
U.S.A.

Trimble

Bluetooth Technology for the Field Surveyor

Peter Large, Trimble Integrated Surveying Group, Westminster, Colorado, USA

In 1993 Trimble launched the world's first RTK system with an RTK rover. This system, while revolutionary, required up to six cables. In 1997 Trimble released another world first: the 4800 GPS Total Station® system, an all-on-the-pole RTK solution with integrated GPS receiver, GPS antenna, UHF radio, and UHF. This system used only one cable, which was a vast improvement on its predecessor. However, even this advanced solution has now been superceded by Trimble's latest technologically innovative product releases.

Trimble's 5800 RTK Rover, ACU Controller, and BlueCap™ module for the TSCe™ Controller offer surveyors the world's first integrated GPS receiver, antenna, UHF radio, battery, and Bluetooth wireless technology, creating pole configurations that are entirely cable free. They satisfy the demands of customers for fewer cables and easier setup of RTK solutions on the pole, or on vehicles and ATVs.

This paper explains Bluetooth technology and outlines its significant benefits for surveyors when integrated in Trimble products.

What is Bluetooth?

Bluetooth wireless technology is an international specification for a compact, low-cost radio solution that links portable devices and connects to the Internet. It is the result of an unprecedented collaboration of leaders in the telecommunications, electronics, computing, and networking industries[1] to create a standard for eliminating cables. This collaboration— the Bluetooth Special Interest Group (SIG)—is backed by 2,000 Adopter/Associate member companies. These companies, of which Trimble is one, are leading the way in offering cable-free solutions.

[1] 3Com, Ericsson, IBM, Intel, Lucent, Microsoft, Motorola, Nokia, and Toshiba

The Bluetooth SIG's vision is greater than just advancing technology. Its vision is to provide the right technology to meet the needs and expectations of the customer, who will ultimately enjoy the benefit of a cable-free environment.

Where did the Name "Bluetooth" Come From?

The name comes from a King of Denmark who lived more than a thousand years ago. His name was Harald Blåtand, the English translation of which is "Bluetooth". According to legend, he united parts of Scandinavia before being killed in battle by his own son "Forkbeard" back in the 10th Century AD. Ten centuries later, the Swedish company Ericsson chose this name for the new technology as a reflection of the vision to unite cable replacement technology in the same way Blåtand sought to unite Scandinavia. Trimble is proud to be part of this revolution and to once again offer a first to the world of the 21st Century surveyor.

How Does Bluetooth Work?

Bluetooth devices are miniature, short-range radio transceivers that work in the international industrial, scientific, and medical devices (ISM) band of 2.45 GHz. Their typical working range is up to about 10 m (33 ft).

Bluetooth is more than just a radio solution: Bluetooth devices are able to find each other and establish communication without user intervention. When any two Bluetooth devices come into range, they automatically detect each other and establish a "conversation" to find out whether or not they are supposed to communicate. If they are, they then establish what is referred to as a "piconet" or personal area network (PAN). This process only takes a few seconds, and afterwards data transfer can occur.

The PAN allows the devices to communicate at high speed using a network protocol (and without a cable). In some cases the communication is just between two devices, and in other cases it is in a network similar to a local area network of computers in an office, but at a smaller "personal" scale.

As a result, Bluetooth technology is very easy to use—after the first configuration, Bluetooth connections are automatic.

Where Can I Use Bluetooth?

Bluetooth devices use the ISM frequency band for communication, the band that is reserved in most countries for low power, short-range radio devices such as wireless garage door openers, cordless telephones, and baby monitors. Generally, these devices do not require a license for owning and operating.

The ISM Frequency Band

Devices using the ISM frequency band must usually meet certain standards, and in order to use the Bluetooth name and logo, any product using Bluetooth must first pass strict qualification, testing, and compliance procedures in accordance with Bluetooth SIG standards. Accordingly, Trimble's 5800 GPS receiver, ACU controller and BlueCap module for the TSCe controller have been tested by an independent authorized consultant and verified to comply.

In some parts of the world—including the United States, member states of the European Union, Australia, and New Zealand—a radio type approval is required. This approval has been obtained for all Trimble products that include Bluetooth. Additionally, Trimble is able to ship Bluetooth products to many states outside the U.S. and E.U.

For more information, please contact your local Trimble dealer, who can be found on the Trimble website at http://www.trimble.com/locator/sales.asp.

Of course, as with any radio equipment, users should always be aware of their responsibilities under the laws of the country of use and ensure they abide by them.

Can Bluetooth Devices Interfere with Each Other?

One of the major design goals of the Bluetooth standard has been to ensure that Bluetooth devices can work alongside each other, whether or not they are intended to communicate.

The technical solution to this problem is the use of a radio technology known as *spread spectrum*. Conventional radio—for example the FM radio stations that can be received from a car radio—separates the different stations by using a different frequency or channel for each station. Many FM radio stations may use the same frequency, but only if their coverage areas do not overlap. If two stations on the same frequency are within range of each other, this will cause interference. Most FM radio listeners have experienced this from time to time when driving through the fringe areas of coverage. Spread spectrum technology allows radio devices to share a frequency without interfering, even if they are within range of each other. The type of spread spectrum used in Bluetooth is called *frequency hopping*. With frequency hopping, the two devices establish the connection and then "hop" around a large portion of the radio spectrum, using a pattern which looks random but which in fact is known precisely by both the transmitter and receiver. Bluetooth devices that have established their piconet hop though 79 different frequencies at a rate of 1,600 frequency changes *every second*.

Because the hopping pattern for each piconet is different, Bluetooth devices in different piconets can be using the same frequency range and be within range of each other, but still not interfere. This is because there enough combinations of those 79 channels and 1/1600th of a second time slots to ensure that they are not on the same channel at the same time. Even if they do land on the same channel for one hop, this condition only lasts for 1/1600th of a second which is not long enough to interfere with communications, given the cyclic redundancy and error checking methods employed.

Another advantage of spread spectrum technology is that it makes the Bluetooth system very resistant to "jamming" from non-Bluetooth devices such as cordless telephones on the same ISM band. If the non-Bluetooth device is not spread spectrum, its signal will transmit on the same frequency, plus or minus a very narrow bandwidth. Because the Bluetooth devices hop around all over a very wide band, if they land in the frequency range of the jammer, they are only there for 1/1600th of a second, which is not long enough to cause interference. As the two Bluetooth devices are so close to each other, interference is unlikely in any case.

Trimble has conducted extensive testing and quality assurance in this respect and has found the system to be extremely robust and reliable.

How Secure is Bluetooth?

The data stream between Bluetooth devices is securely encrypted. Furthermore, the signal is very short range and hops around the frequency spectrum in an apparently random way, making it almost impossible to "eavesdrop".

As all Bluetooth devices automatically detect each other, they must be able to easily identify which devices to connect to and which to ignore. A surveyor working in the field may want a 5800 to connect to an ACU, but does not want to connect to a Bluetooth-enabled cellphone in a passerby's pocket.

To ensure that this does not happen, the Bluetooth standard enables users to establish "trusted devices". A particular Trimble 5800 receiver and Trimble ACU can be set up once as trusted devices and this tells the system that the user only wishes these devices to connect. One the trusted devices have been set up, any other Bluetooth devices coming into proximity of that particular 5800 and ACU will be ignored.

The Bluetooth standard is also flexible enough to manage a pool of equipment that can be mixed and interchanged as trusted devices if desired, for example, a pool of 5800 receivers and a pool of Trimble ACU controllers. When any unit is powered on, it automatically scans for other Bluetooth devices within range and lists any trusted devices found. Usually only one such device will be within range, but even if more than one device is found, the user can select which one to connect to from the list.

The list includes a unique identifier for each device. In the case of the 5800 GPS receiver, the default identifier is the receiver serial number. The software supplied with the 5800 receiver also allows the user to customize or personalize the identification message sent from any receiver, for example, with the owner's name instead of a serial number, which further simplifies identification.

Use of Bluetooth in Trimble Survey Products

The Trimble 5800 GPS receiver, Trimble ACU, and Trimble BlueCap accessory (for the TSCe Controller) are all certified Bluetooth products. The integrated Bluetooth module in the ACU, along with the Microsoft CE.NET operating system, allows a cable-free connection to a 5800 receiver or to other Trimble ACU controllers.

The Trimble BlueCap can be attached to a Trimble TSCe running Microsoft CE.net to achieve the same wireless communication with a 5800 GPS receiver and other TSCe controllers with BlueCap. Trimble ACU controllers can also communicate with Trimble TSCe controllers equipped with the BlueCap and vice-versa.

Cable-Free RTK Rover Pole

For the RTK user in the field, the most immediate advantage of Bluetooth is the ability to operate an all-on-the-pole RTK rover solution that is completely cable free.

This eliminates cable snagging in the rough and is one less thing to forget or to break.

Trimble RTK all on the pole and free of cables.

Remote 5800 Control

The ability to remotely control the 5800 GPS receiver without the need for a cable does not need to be restricted just to the pole. This modular system allows the surveyor to sit in the truck or under the shade of a tree while still controlling an instrument up to 30ft away. It also means that installations of the RTK equipment on vehicles, ATVs, small boats or difficult setups are much quicker and easier as there are no antenna cables or data cables to worry about.

Sit in the truck while still controlling the GPS receiver outside—great for fast static on hot or cold days.

Use the multi-tasking environment to check or enter data while still connected to the receiver

The true multi-tasking capabilities of Trimble Survey Controller and Trimble Survey Pro mean users can enter data or check plans while still connected to the receiver conducting a survey—the survey is not interrupted.

Sharing Data in the Field

Just as conventional RTK systems need a cable to connect between sensor and controller, conventional systems also require some physical device such as a PC card to pass data between devices in the field. Bluetooth eliminates the need for such physical devices by allowing the direct transfer of data across the air.

Sharing a complete job file, set of control points, site calibration, DXF background map, feature code library, or geoid model between crewmembers in the field is easy with Bluetooth. Or transfer the survey job map to the other crewmembers to fill in gaps.

The Bluetooth standard, along with the Microsoft CE.Net operating system, also supports multiple Bluetooth channels simultaneously. This means that, for example, an RTK rover in the field can send data to another controller *while still carrying on the survey and logging data from the GPS receiver*. Even while the data transfer between controllers is being carried out, the data from the GPS receiver will still be logged.

Can I Use Bluetooth to Connect to a PC or Cellphone?

The current Bluetooth implementation in Trimble products is intended as a cable replacement between certain trusted devices and thus is a point-to-point system for Trimble products only. This ensures maximum reliability, ease of use, and security. Connecting Trimble Bluetooth devices to non-Trimble devices such as cellular telephones or PC cards is not supported.

Transfer data between ACU controllers and continue to log data form the receiver—both at the same time.

RTK Roving on a Vehicle

The 5800 RTK Rover can be mounted on the roof or mast of a vehicle and the controller operated from inside. In these situations, cable-free technology enables surveyors to travel over rugged terrain, collecting data without risking downtime due to cable failure.

Conclusion

To learn more about how Trimble total surveying solutions can help you and your business, or to see for yourself the world's first Bluetooth-enabled surveying equipment, we invite you to contact your local Trimble representative, who will be pleased to give you a demonstration.

To locate your nearest Trimble dealer, visit our website below http://www.trimble.com/locator/sales.asp.

Trimble